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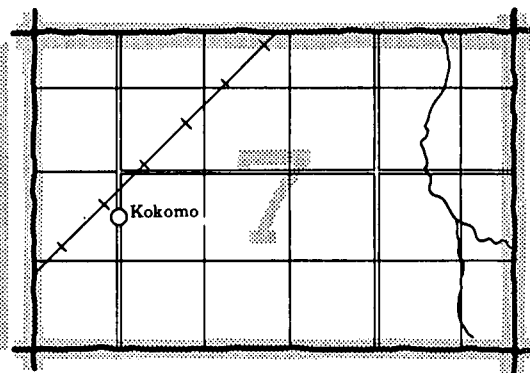
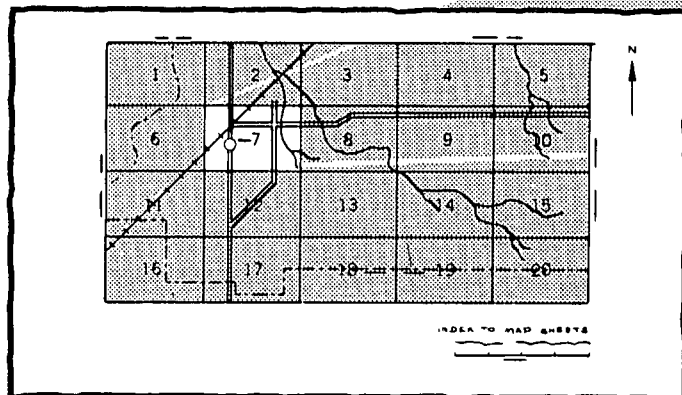
In cooperation with  
Conservation and  
Survey Division  
University of Nebraska

# Soil Survey of Cedar County Nebraska



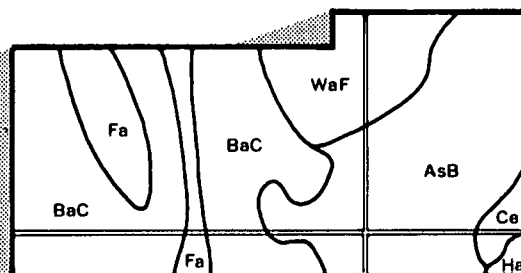
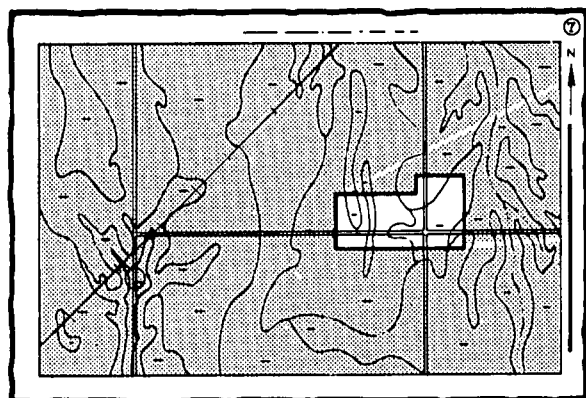
# HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets."

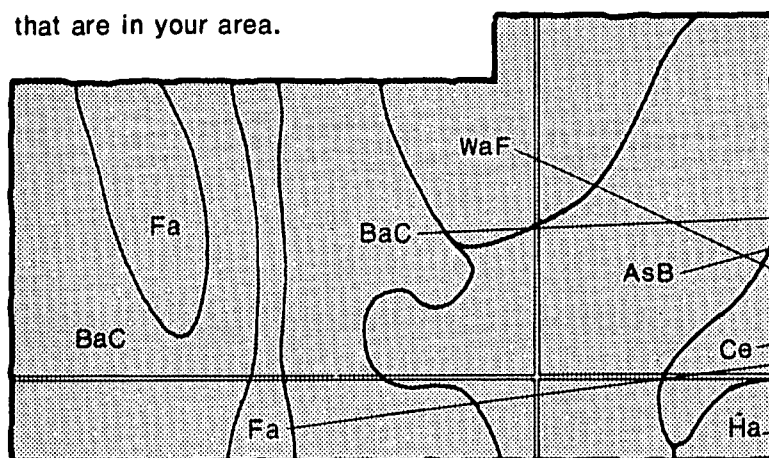


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



4. List the map unit symbols that are in your area.



## Symbols

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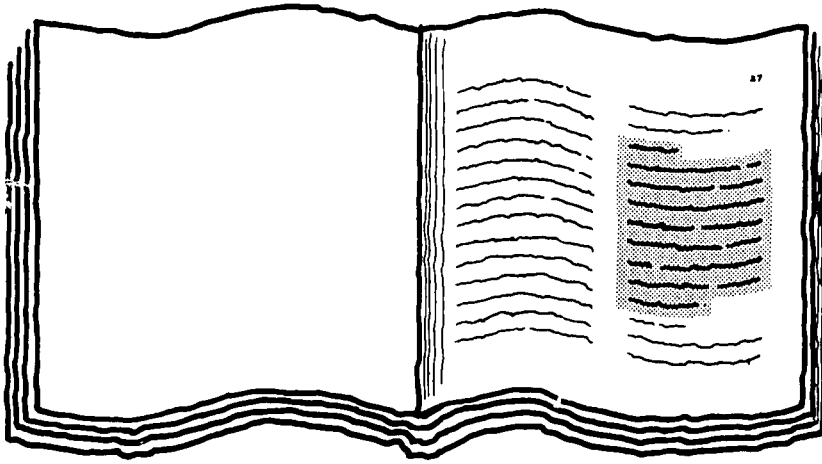
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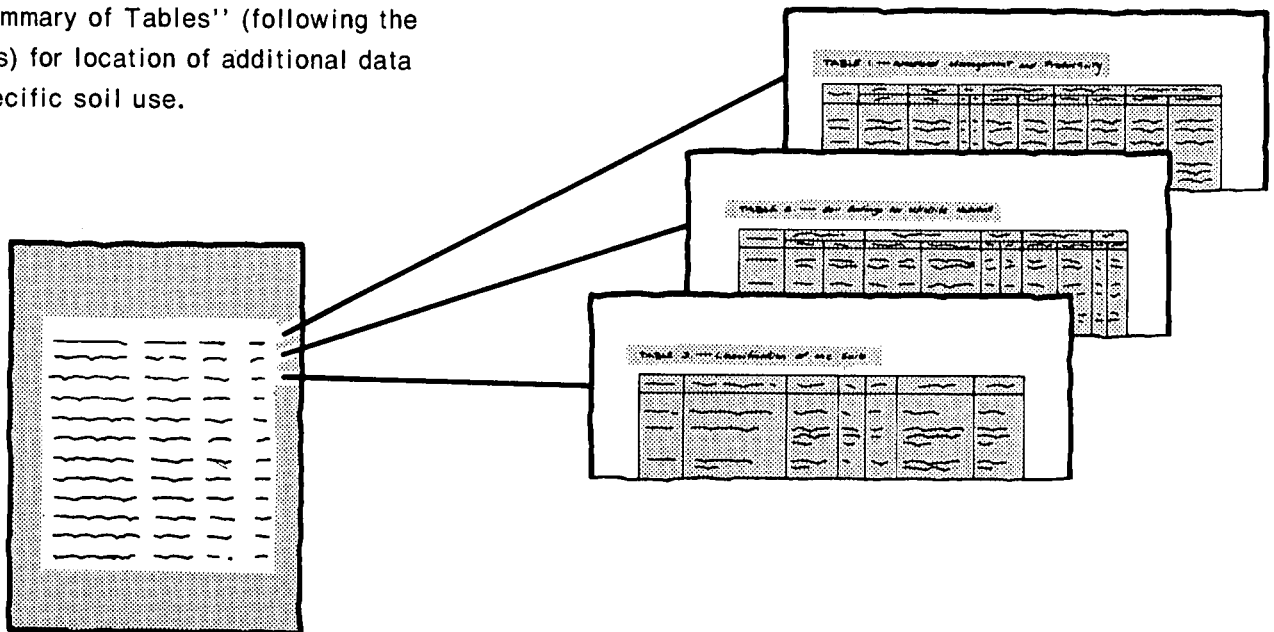
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# THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

A detailed illustration of a table with multiple columns and rows, representing the 'Index to Soil Map Units'. The table is shaded and has a grid-like structure with various lines and text within the cells.

6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

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This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and state agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Lower Elkhorn and the Lewis and Clark Natural Resources Districts. The Cedar County Commissioners, the Lewis and Clark Natural Resources District, and the Lower Elkhorn Natural Resources District provided financial assistance to this survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

This soil survey supersedes the soil survey of Cedar County, Nebraska, published in 1928.

**Cover: Terraces, grassed waterways, and contour farming in an area of the Loretto-Thurman-Ortello association help to conserve water and to control erosion. The windbreak protects the farmstead and feedlot, which are in the Aowa-Shell-Hobbs association.**



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# Foreword

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This soil survey contains information that can be used in land-planning programs in Cedar County, Nebraska. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

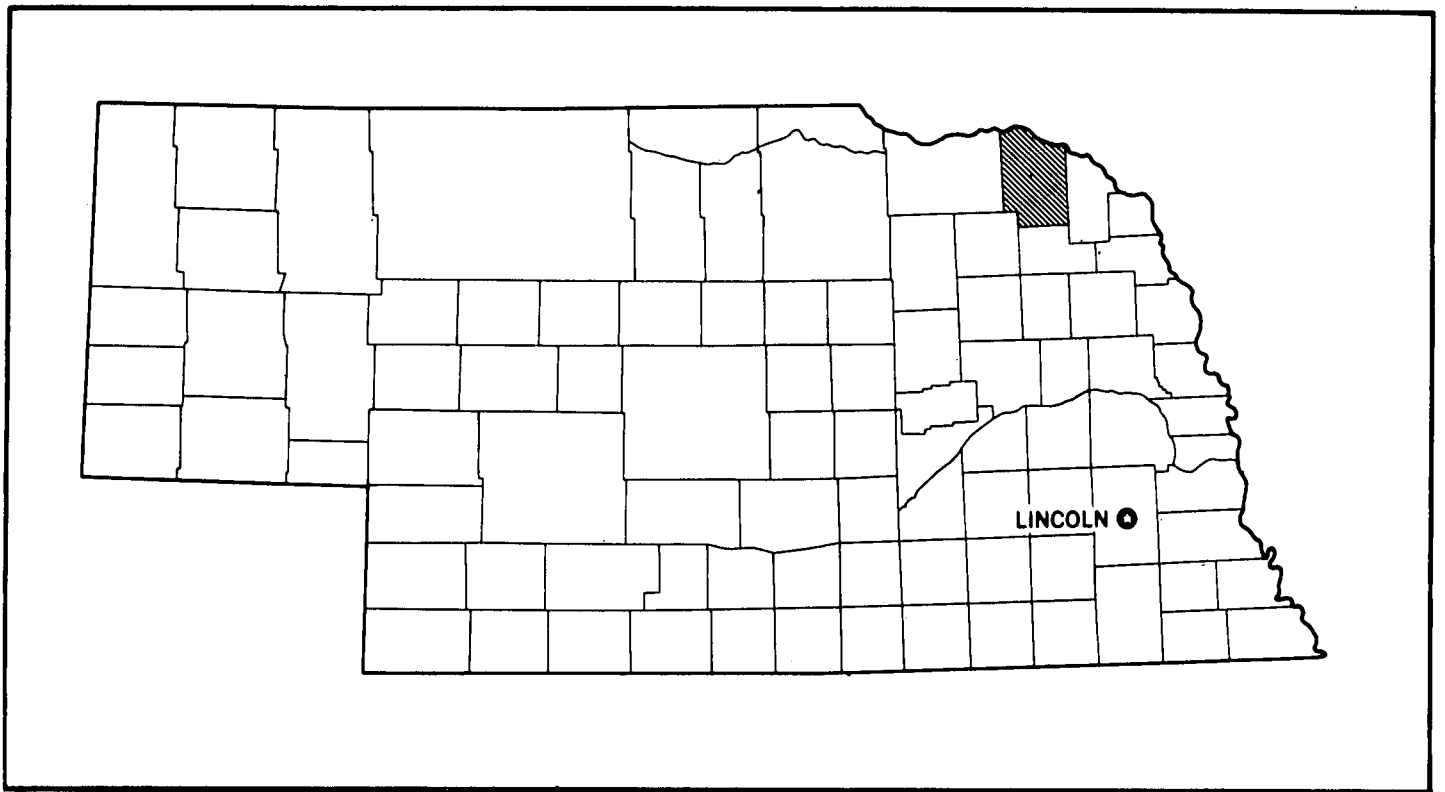
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



Sherman L. Lewis  
State Conservationist  
Soil Conservation Service



Location of Cedar County in Nebraska.



# Soil Survey of Cedar County, Nebraska

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United States Department of Agriculture, Soil Conservation Service  
In cooperation with  
Conservation and Survey Division, University of Nebraska

CEDAR COUNTY is in the northeastern part of Nebraska. It is bounded on the north by South Dakota, on the west by Knox County, on the south by Pierce and Wayne Counties, and on the east by Dixon County. It is part of the Loess, Till, and Sandy Prairies Major Land Resource Area (3). The total land area is approximately 473,625 acres, or about 740 square miles, in 21 townships. The county is roughly rectangular in shape, but its northern boundary, which follows the Missouri River, is irregular. The county is about 36 miles long and 24 miles wide. The state boundary and the county boundaries, as shown on the maps in this survey, are approximate along the Missouri River and along borders where county lines are not well defined by roads.

At present, the county is served by one railroad, which runs parallel to U.S. Highway 20 in the southern part of the county. There are about 166 miles of hard-surfaced roads in the county. There are about 1,177 miles of county roads, mainly on section lines. Most county roads are graveled. U.S. Highway 81 is in the western part of the county. State Highways 12, 15, 57, and 84 also serve the county. Gavins Point Dam, on the Missouri River, is in the northwest corner of the county. It provides electric power and flood control as well as recreation facilities. The reach of the Missouri River bounding Cedar County is in a relatively natural state.

Farming is the principal occupation in the county, and most employment is in farming or related businesses. Feed grains, forage crops, and cash-grain crops are grown. Sand and gravel pits supply material for

maintaining county gravel roads and some aggregate for concrete. There are a few small industries in Hartington.

The most important natural resource of Cedar County is its soil. The soils formed mainly under grass vegetation (7). In the uplands the most extensive parent material is Peoria loess. In the northern part of the county the parent material includes glacial till and glacial outwash, eolian material, residuum of soft sedimentary rock, and colluvium and alluvium derived from all of these materials. After being sufficiently altered by the soil-forming processes, parent material is classified as soil. The suitability of a soil for most uses depends mainly on its texture, structure, slope, fertility, available water capacity, and drainage.

## General Nature of the County

This section provides information about Cedar County. It discusses history and development; climate; geology and ground water resources; physiography, relief, and drainage; and agriculture.

## History and Development

As early as 1739, trappers and traders traveling along the Missouri River explored the area of what is now Cedar County. Tribes of Ponca, Sioux, and Omaha Indians were living there. In 1804, the Lewis and Clark Expedition, traveling up the Missouri River, passed by

the area on its journey to explore the land acquired by the Louisiana Purchase.

In 1854 the Kansas-Nebraska Act created the Territory of Nebraska. Cedar County was established 3 years later by an act of the Territorial Legislature. The county was named for its numerous redcedar trees. Settlers were already taking up residence in the area. Old St. James was the first town established in Cedar County, and Fort Jackson was built nearby. The Pacific Wagon Road ran through the county along Bow Creek and East Bow Creek. It was used for army transport as well as by settlers and traders.

The pioneers in Cedar County lived in dugouts, sod houses, and log cabins. In the first decade of the county's existence, at least three mills for sawing timber and grinding flour were built on tributaries of the Missouri River. The Homestead Act went into effect in 1863. Under its provisions, a homesteader could claim a 160-acre tract of unoccupied public land and acquire title to the land by farming it for 5 years. However, the settlers had to contend with floods on the Missouri River bottom lands, blizzards, prairie fires, grasshopper plagues, drought, and disease. Many of the settlers could not hold out and were forced to leave the county between 1860 and 1880.

In 1883 the Northwestern Railroad opened a line entering the county from the southeast. During the next 25 years, as a railroad boom swept the country, more railroad lines and branches were built or projected in the county. Trading opportunities flourished as the railroads offered the first rapid and reliable transportation of farm products to distant markets. Today the agricultural products of Cedar County are transported mainly by truck. A century ago, the price of common land in the county ranged from 3 to 5 dollars an acre (5). The social and economic life of the county, from the days of the pioneers to the present, has centered on agriculture.

Since 1885, Hartington, which is located near the center of the county, has been the county seat. It is the largest town in Cedar County and has a population of 1,730. In 1930, the population of Cedar County was 16,427, and in 1980, it was 11,375.

## Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

In Cedar County winters are cold and summers are quite hot with occasional cool spells. In winter precipitation occurs frequently as snowstorms, and during the warm months it occurs mainly as showers, often heavy, when warm, moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Hartington, Nebraska, in the period 1951 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in

spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22 degrees F, and the average daily minimum temperature is 11 degrees. The lowest temperature on record, which occurred at Hartington on January 29, 1966, is -28 degrees. In summer the average temperature is 74 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred on July 12, 1954, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 25 inches. Of this, 19 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 3.28 inches at Hartington on October 16, 1968. Thunderstorms occur on about 45 days each year, and most occur in summer.

The average seasonal snowfall is 34 inches. The greatest snow depth at any one time during the period of record was 35 inches. On an average of 25 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northeast. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally. These storms are local and of short duration and result in sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

## Geology and Ground Water Resources

The bedrock underlying Cedar County consists of the Carlile Shale, Niobrara Formation, and Pierre Shale of the Cretaceous Period and the Ogallala Formation of the Tertiary Period. Carlile Shale is exposed only in parts of the extreme eastern and northeastern borders of the county. Pierre Shale is in areas of the western part of the county. Niobrara Formation constitutes the bedrock in the rest of the county except where it is overlain by the Ogallala Formation. Although the Ogallala Formation is considered bedrock, it consists predominantly of poorly consolidated fine sand, silt, and some clay. It is mainly in the central part of the county and reaches a

maximum thickness of about 100 feet in an area along Highway 81 about 5 miles south of Highway 84. It is exposed at the surface in a few places near Hartington.

Rocks of Cretaceous age are exposed in numerous places, mainly along the bluffs of the Missouri River and along the valley sides of some drainages into the Missouri River. Niobrara Formation and Pierre Shale are exposed or are near the surface in a large area between Bow Creek and Second Bow Creek, south and west of St. Helena.

Unconsolidated sediment of Quaternary age overlies the bedrock throughout most of the county. The sediment consists of wind-deposited silt, or loess; ice-deposited silty clay that has rock fragments ranging from pebble to boulder size, or glacial till; water-deposited silt, sand, and gravel; and lake deposits of silt and clay.

There is glacial till throughout most of the southern part of the county and along the higher ridges in the northern part. In most of the major stream valleys the till has been eroded, but in an area around Coleridge and in the southwest corner of the county it is more than 150 feet thick. In some places the till is interbedded with sand and gravel deposited by glacial meltwater, but generally the meltwater deposits are beneath the till and rest on bedrock.

In the northern part of the county, where there is no till, sand and gravel are commonly close to the surface. Sand and gravel have also been deposited in the Missouri River Valley. Loess mantles most of the county, but some areas have been eroded.

There is an adequate supply of ground water for domestic use throughout most of the county. In the northern part of the county it can be difficult to find a satisfactory supply of ground water. There is an adequate supply of water for irrigation wells in about half the county, mainly in the southern and central parts and on the bottom lands of the Missouri River in the extreme northern part. Water quality may be a factor in determining whether the ground water can be used either for irrigation wells or for domestic use.

In the southern part of the county most wells are drilled into sand and gravel of Quaternary age that generally overlie the bedrock. In upland areas in the south-central and southwestern parts of the county, sand and gravel commonly range from 40 to 100 feet in thickness and in some places are buried by more than 200 feet of glacial till. The wells generally range from 120 to 360 feet in depth, and the water level is at a depth of 50 to 325 feet. Irrigation wells in the southern part of the county generally yield from 600 to 1,200 gallons per minute (gal/min). In some areas the sand and gravel may not be thick enough to supply an irrigation well.

In the southeastern part of the county, along the valleys of Logan Creek and its tributaries, the wells generally range from 40 to 120 feet in depth, and the water level is at a depth of less than 5 to about 40 feet.

The thickness of the sand and gravel generally ranges from 20 to 60 feet. In most areas north of Laurel and east of Highway 57, there is a limited supply of ground water for high capacity wells.

In most of the northern half of the county, the bedrock is much shallower and the sand and gravel are much thinner. The sand and gravel commonly are dry; they have been drained by the downcutting of the Missouri River. There are some high capacity wells, however, in the Niobrara Formation, in which water is stored and transmitted along openings in the bedrock, such as fractures and solution cavities. A well must encounter one of these openings to produce a high yield. Thus, well yields may vary over a short distance. Some wells yield water from both the Niobrara Formation and the overlying sand and gravel. The wells generally range from 60 to 100 feet in depth, and the water level is at a depth of less than 5 to 40 feet. Some wells in the Niobrara Formation yield as much as 500 to 900 gal/min.

Wells on bottom lands along the Missouri River are drilled into alluvial sand and gravel. The wells range from 40 to 115 feet in depth. The water level is at a depth of less than 5 to about 20 feet, and yields of 1,000 gal/min are common.

In the sand and gravel and in the Niobrara Formation water quality generally is suitable for both domestic and irrigation uses. In some places it is unsuitable for domestic use because the water is quite hard and is high in iron and manganese. In some places, mainly the central and northern parts of the county, the highly mineralized water may require salinity control measures for irrigation use.

The fine-grained sandstone of the Dakota Formation is a potential source of water. The Dakota Formation is at a depth ranging from about 900 feet in the southern uplands to about 300 feet on the bottom lands of the Missouri River. In the uplands the depth to water may be as much as 500 feet, while along the bluffs of the Missouri River there are flowing wells. Well yields can be as much as 500 gal/min, but the potential for large capacity wells depends on the thickness of the water-yielding sandstone.

Water from the Dakota Formation generally is hard and is high in sulfate, iron, and manganese. Water quality may be unsuitable for domestic use, and salinity control measures may be needed for irrigation use.

## Physiography, Relief, and Drainage

Thousands of years ago, during the Ice Age, glaciers covered Cedar County. Later, high winds deposited and sorted soil material across the county. The result of these processes is a complex surface mantle of mixed and varied parent material. Generally, the topography of the county is related more closely to the eroding of the

various and relatively friable surface deposits than to the more resistant sedimentary bedrock.

Generally, the topography of Cedar County consists of a strongly dissected plain sloping toward the north and east. There are a few nearly level upland remnants in the southern part of the county.

The highest elevation is about 1,930 feet in the southwestern corner of the county near Magnet, and the lowest elevation is about 1,120 feet in the northeastern corner, where the Missouri River flows out of the county. The average elevation in the county is about 1,550 feet. The most prominent landforms are the upland bluffs and the adjacent loess hills, especially in the eastern part of the county where the bluffs break sharply to the bottom lands of the Missouri River. In these areas the slope is steep and very steep. The relative difference in elevation between the ridgetops and the bottom of the adjacent drainageways is about 100 to 280 feet.

About 81 percent of the county is upland, and the rest is terraces and bottom lands. About 20 percent of the terrain is level and nearly level, and slope is 0 to 2 percent; about 1 percent is nearly level and very gently sloping, and slope is 0 to 3 percent; about 25 percent is gently sloping, and slope is 2 to 6 percent; about 38 percent is strongly sloping, and slope is 6 to 11 percent; about 9 percent is moderately steep, and slope is 11 to 15 percent; about 6 percent is steep, and slope is 15 to 30 percent; and about 1 percent is very steep, and slope is 30 to 60 percent.

Except in the areas of bluffs along the Missouri River, the drainageways are not sharply cut and the hills generally are rounded. Drainageways extend into all parts of the uplands, and there are no large, flat, underdrained plain remnants or depressions. On about 5 percent of the soils, internal drainage is restricted, and special management or design is needed for most uses.

Cedar County is drained entirely by the Missouri River and its tributaries. In about 75 percent of the county, drainage is northerly into the Missouri River. The main drainage system consists of Bow Creek and its tributaries. In the southern 25 percent of the county, drainage is mainly into Logan Creek and its tributaries and thence by way of the Elkhorn and Platte Rivers into the Missouri River.

From late in winter through early in summer, intermittent upland drains and perennial streams are subject to common flooding. In dry summers, even perennial streams commonly dry up in places. Before Gavins Point Dam was completed in 1956, the bottom lands of the Missouri River were subject to common flooding and flood damage was severe. In some drainageways flooding has become less frequent because of the installation of farm ponds, diversions, terraces, grassed waterways, and other conservation measures and practices. In other areas the hazard of flooding has been increased by poor land management. On flood plains there generally is little flood damage to

crops, but flood damage could be considerable if the soils on flood plains were used for urban development.

## Agriculture

Originally, Cedar County was covered by a luxuriant growth of prairie grasses, and cattle grazing was the first important enterprise. However, as more settlers arrived and as railroads were developed, ranching was replaced to a great extent by farming. In the early years agriculture developed slowly because of the great distances to markets and the ravages of insect pests. In some years grasshoppers were very destructive, but each year farmers sowed larger acreages of crops in an effort to recuperate from the losses of previous years. The farmers had little capital to tide them over disastrous years and consequently had to endure great hardships until the next harvest.

During the 1930's severe crop failures and alarming losses of topsoil led to general recognition of the need for soil and water conservation and widespread acceptance of conservation practices. In 1944, the Cedar County Soil and Water Conservation District was organized. Today, the Lewis and Clark and the Lower Elkhorn Natural Resources District assists land users in Cedar County in incorporating soil and water conservation practices in land use.

The climate is favorable for cash-grain and livestock farming, and most farm enterprises combine the two. About 71 percent of the land area is cropland, according to the 1978 Census of Agriculture, and about 14 percent is woodland, pasture, and rangeland. About 18 percent of the cropland is irrigated. Most irrigation water comes from wells. In 1978, there were 402 registered wells, or slightly more than one well for every 2 sections, or 2 square miles, of land area (4).

Erosion is the severest hazard on the soils in the county. It is the main management problem on about 75 percent of the soils. Flooding and wetness are limitations on about 14 percent of the soils. Controlling erosion and preventing flooding are the main management concerns.

Most large pastures and native grasslands are in the northern part of the county on soils that formed in various parent materials. The only extensive woodlands are on the steep uplands of the Missouri River bluffs and in a few areas adjacent to the bluffs; there are some stands of trees along the channels of drainageways and in a few isolated tracts on the bottom lands of the Missouri River. Trees and shrubs are planted extensively in windbreaks for farmsteads.

According to the dryland capability classification, about 5.4 percent of the total land area consists of Class I soils, 30.3 percent of Class II soils, 25.4 percent of Class III soils, 27.2 percent of Class IV soils, 0.3 percent of Class V soils, 9.1 percent of Class VI soils, 1.9 percent of Class VII soils, and 0.4 percent of Class VIII soils.

Corn has always been the main crop in the county. It is grown as a cash-grain crop and a feed crop for finishing beef cattle and hogs for market. It is chopped and ensiled, commonly in upright silos for dairy cattle and in trench silos for beef cattle. In recent years irrigation has been used widely for corn and has helped to guarantee consistently high yields. On uplands, the acreage of irrigated corn has greatly increased with the introduction of center pivot irrigation and other types of sprinkler systems. Yellow field corn is the type now grown, but at one time white corn commonly was grown. In 1925, under dryland management, the average yield was 23 bushels per acre. Since then, the average annual yield has more than tripled.

Oats have always been the dominant small grain grown in the county. In the past 50 years, oat yields have almost tripled because of the combined effects of improved varieties, cultural practices, and management. Oats are both a cash-grain and a feed crop. Oat straw is used for feed and bedding. Oats are more extensively grown in the northern part of the county, where the soils are more droughty and where the available ground water is insufficient to irrigate corn. The precipitation is ample in spring and early in summer, when oats mature. Generally, irrigation of oats is neither profitable nor necessary. However, oats are commonly sown as a nurse crop with new seedings of alfalfa and are then irrigated by a center pivot irrigation system. Oats are generally sown by broadcasting.

In the past, rape generally was planted with oats for winter pasture, especially for draft horses. Barley is grown on a small acreage in place of oats in the crop rotation, and most of the grain is used for feed. A few acres are planted to winter wheat and spring wheat.

Since 1899, alfalfa has become increasingly the most important hay crop. Three or four cuttings of alfalfa are usually harvested. Most of the hay is fed to livestock on the farms where it is produced. Some alfalfa is processed by dehydration plants into feed products. Alfalfa blossoms provide most of the nectar for the honey industry in the county. Sweet-clover is also grown on a few acres.

Native grass hay has decreased in importance as alfalfa has increased and as the demand for native hay for workhorses and mules has declined. Native hay is used mainly for feeding horses and calves. Since the mid-1930's, brome grass has become the dominant domesticated grass in the county. It is the main cool-season pasture grass and is commonly established in road ditches and along fencelines. A very small amount of brome grass is cut for hay.

In the last 15 years, soybeans have increased in importance in the county. In 1978, the acreage of soybeans harvested was second only to that of corn. Soybeans generally are more drought resistant than corn. Yields continue to improve because of improved varieties, cultural practices, and irrigation.

Sorghum is grown on a small acreage and is used mainly for feed. Rye, flax, timothy, clover, potatoes, sugar beets, and truck crops have been of minor importance in the county. A few fruit trees and grapes are grown by gardeners. In the southern part of the county there are a small Christmas tree farm and a small nursery.

In 1978, Cedar County ranked first in Nebraska in number of milk cows and in milk production (6). Dairying generally has increased in importance over the last 50 years, but in recent years it has decreased slightly. A cheese plant in Hartington processes a significant amount of the milk produced in the county into cheese products.

In 1978, Cedar County ranked third in Nebraska in number of hogs. Although beef cattle far outnumber dairy cattle, they were fewer in number than the hogs produced in 1978, even though the value of the beef cattle exceeds that of the hogs.

Percheron and Belgian draft horses and mules were commonly used on most farms 50 years ago, but today most horses in the county are kept for pleasure riding. Some sheep are raised, mainly in small flocks. Poultry and eggs are not so important today as they were some years ago. On some farmsteads a small flock of poultry is kept for family use.

In recent years, agriculture has changed rapidly. A current trend is the expansion of family farms, resulting in larger units operated by fewer farmers. Larger production capacities of buildings, more confinement livestock production systems, and more sophisticated equipment in all operations have increased the production per man-hour of input. Use of sprinkler irrigation systems, particularly center pivot irrigation systems, and extensive use of herbicides, pesticides, and fertilizers all contribute to good yields. On-farm storage bins are being used more and more as an alternative to storing grain in local elevators. The farmers of the younger generation generally are better educated, are applying intensive management and computerized technology, and are becoming more specialized in their farm operations.

In keeping with these trends, larger fields are farmed. Old fence rows and many acres of trees and brush have been cleared to enlarge cultivated areas. The permanent loss of cover has had a detrimental effect on wildlife. In addition, older soil and water conservation installations have been destroyed or have not been maintained. Effective modern conservation measures can be designed to provide habitat for wildlife as a secondary benefit.

Soil erosion remains the biggest threat to the fertile soil in Cedar County. The soil must not be managed for short-term high crop yields at the cost of excessive loss of water and topsoil.

## How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

This soil survey supersedes the first soil survey of Cedar County, published in 1928 (7). This survey provides additional information and contains photomaps that show the location and extent of the map units.

## Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and



some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been

observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.



# General Soil Map Units

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The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one soil association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

## Nearly level to moderately steep, silty soils on uplands

The soils in this group are deep and well drained. Most of the acreage is cultivated and dry-farmed. Some of the acreage is irrigated, mainly by a center-pivot sprinkler system. A small acreage is in introduced or native grasses. Water erosion is the main hazard. Conserving water for plant use and maintaining fertility are the main concerns in management.

### 1. Nora-Crofton-Moody Association

*Deep, nearly level to moderately steep, well drained, silty soils that formed in loess; on uplands*

This association consists mainly of soils on uplands (fig. 1). The slope ranges from 0 to 15 percent.

This association takes in about 175,030 acres, or 39 percent of the county. It is about 31 percent Nora soils, 30 percent Crofton soils, 15 percent Moody soils, and 24 percent minor soils.

Nora soils are gently sloping to moderately steep; they are on narrow divides and side slopes along intermittent drainageways. Typically, the surface layer is brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam 21 inches thick. The upper part is brown, and the lower part is pale brown and calcareous. The underlying material is calcareous silt loam to a depth of more than 60 inches. It is pale brown in the upper

part, light brownish gray in the middle part, and light gray in the lower part.

Crofton soils are gently sloping to moderately steep; they are on the steepest divides and convex upper slopes along intermittent drainageways. Typically, the surface layer is grayish brown, friable silt loam about 5 inches thick. A transitional layer is pale brown, friable silt loam about 7 inches thick. The underlying material is silt loam to a depth of more than 60 inches. The upper part is pale brown, and the lower part is very pale brown. The soil is calcareous throughout.

Moody soils are nearly level to strongly sloping; they are on the broader divides and upper concave side slopes along intermittent drainageways. Typically, the surface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is silty clay loam about 39 inches thick. The upper part is friable and dark grayish brown, the middle part is firm and brown, and the lower part is friable and pale brown. The underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches.

The minor soils are mainly Alcester soils. Other minor soils are Aowa and Loretto soils. Alcester soils are on lower concave foot slopes adjacent to drains; they have dark colors to a depth of more than 20 inches. Aowa soils are on narrow flood plains of intermittent drains and are subject to occasional flooding; they are thinly stratified. Loretto soils have more sand throughout and are in positions similar to those of Moody soils.

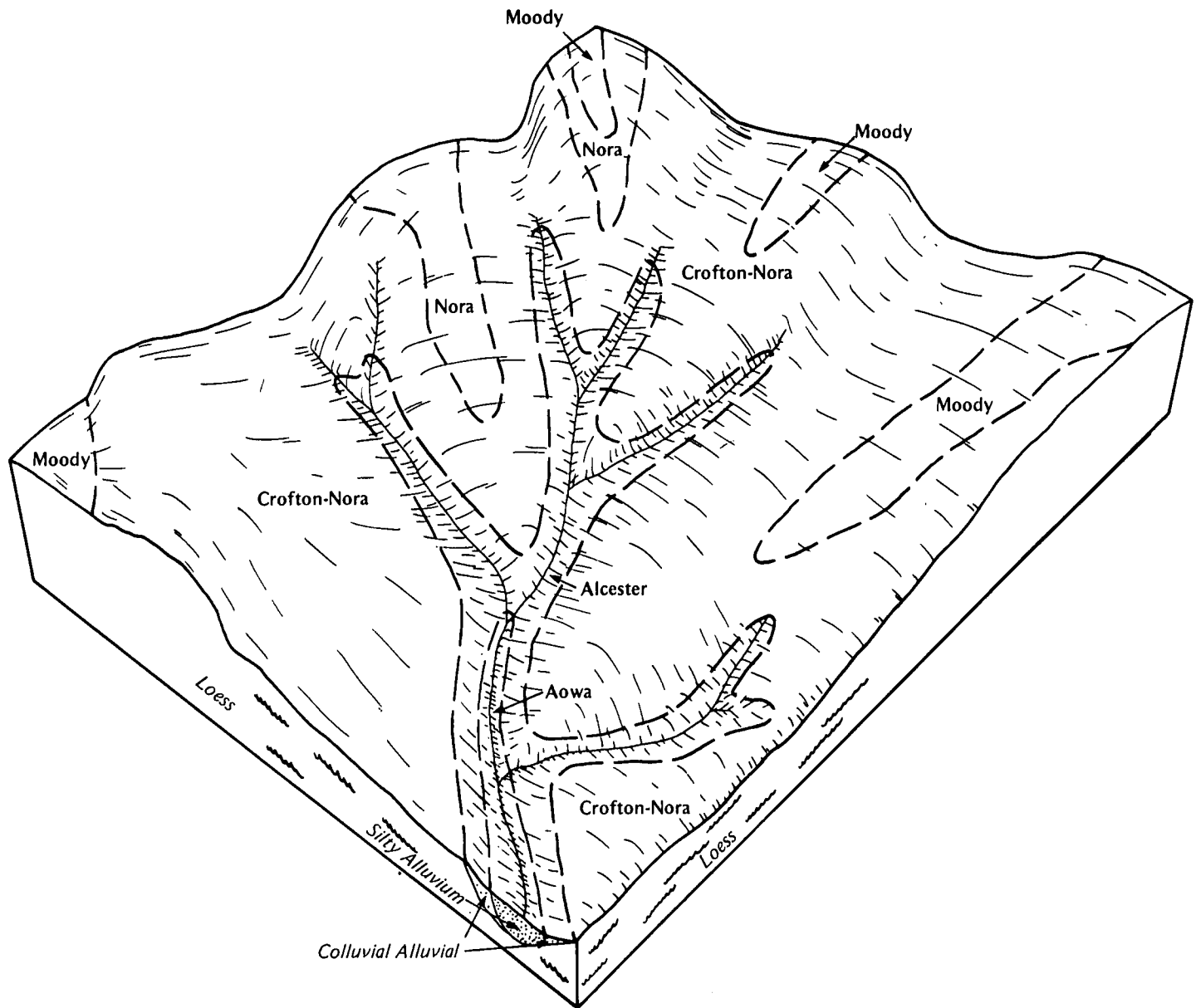
Farms in the areas of this association are mainly cash grain-livestock enterprises. Most of the acreage is in cultivated crops. The main crops are corn, soybeans, alfalfa, and oats. About 80 percent of the acreage is dry-farmed, and 20 percent is irrigated. Deep wells supply the irrigation water. Livestock on the farms are mainly beef and dairy cattle and hogs.

Water erosion is a hazard in cultivated areas. Conservation tillage and terraces help to control water erosion and to conserve moisture. In irrigated areas, it is necessary to apply adequate amounts of irrigation water, but the rate of application must be controlled to minimize erosion.

### 2. Moody-Nora Association

*Deep, nearly level to strongly sloping, well drained, silty soils that formed in loess; on uplands*

This association consists mainly of soils on broad upland flats and along intermittent drainageways (fig. 2). The slope ranges from 0 to 11 percent.



**Figure 1.—Typical pattern of soils in the Nora-Crofton-Moody association and the relationship of the soils to topography and parent material.**

This association takes in about 35,000 acres, or 7 percent of the county. It is about 77 percent Moody soils, 17 percent Nora soils, and 6 percent minor soils.

Moody soils are nearly level to strongly sloping; they are on broad upland flats and along intermittent drainageways. Typically, the surface layer is dark grayish brown, friable silty clay loam about 9 inches thick. The subsurface layer is also dark grayish brown, friable silty clay loam; it is about 3 inches thick. The subsoil is friable silty clay loam about 34 inches thick. In the upper part it is brown, and in the lower part it is yellowish brown. The

underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches.

Nora soils are gently sloping to strongly sloping; they are on slopes of intermittent drainageways. Typically, the surface layer is brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam 21 inches thick. In the upper part it is brown, and in the lower part it is pale brown and calcareous. The underlying material is calcareous silt loam to a depth of more than 60 inches. It is pale brown in the upper part,

light brownish gray in the middle part, and light gray in the lowest part.

The minor soils are Alcester, Aowa, and Crofton soils. Alcester soils are on slightly concave upland foot slopes adjacent to intermittent drainageways. They have dark colors to a depth of more than 20 inches. Aowa soils are on bottom lands and are stratified throughout. Crofton soils are on the steepest divides and most convex slopes. They do not have a dark colored surface layer.

Farms in areas of this association are grain and livestock enterprises. Most of the acreage is in cultivated crops. The main crops are corn, soybeans, alfalfa, and oats. About 80 percent of the acreage is dry-farmed, and about 30 percent is irrigated. Deep wells supply the irrigation water. Livestock on the farms are mainly swine or beef and dairy cattle.

Water erosion is a hazard in cultivated areas that are gently sloping and strongly sloping. Conservation tillage and terraces help to control water erosion and to conserve moisture. In irrigated areas, it is necessary to apply adequate amounts of irrigation water, but the rate of application must be controlled to minimize erosion.

### 3. Eltree-Crofton Association

*Deep, nearly level to moderately steep, well drained, silty soils that formed in loess; on uplands*

This association consists mainly of soils on upland crests adjacent to the breaks of the bottom lands of the Missouri River. The slope ranges from 0 to 15 percent.

This association takes in about 5,545 acres, or 1 percent of the county. It is about 74 percent Eltree soils, 14 percent Crofton soils, and 12 percent minor soils.

Eltree soils are on the more gentle slopes and broader divides. Typically, the surface layer is grayish brown, friable silt loam about 8 inches thick. The subsurface layer is also grayish brown, friable silt loam; it is about 18 inches thick. The subsoil is light brownish gray, friable silt loam about 32 inches thick. The underlying material is light gray silt loam to a depth of more than 60 inches.

Crofton soils are in the steeper and most convex positions. Typically, the surface layer is grayish brown, friable silt loam about 5 inches thick. A transitional layer is pale brown, friable silt loam about 7 inches thick. The underlying material is silt loam to a depth of more than

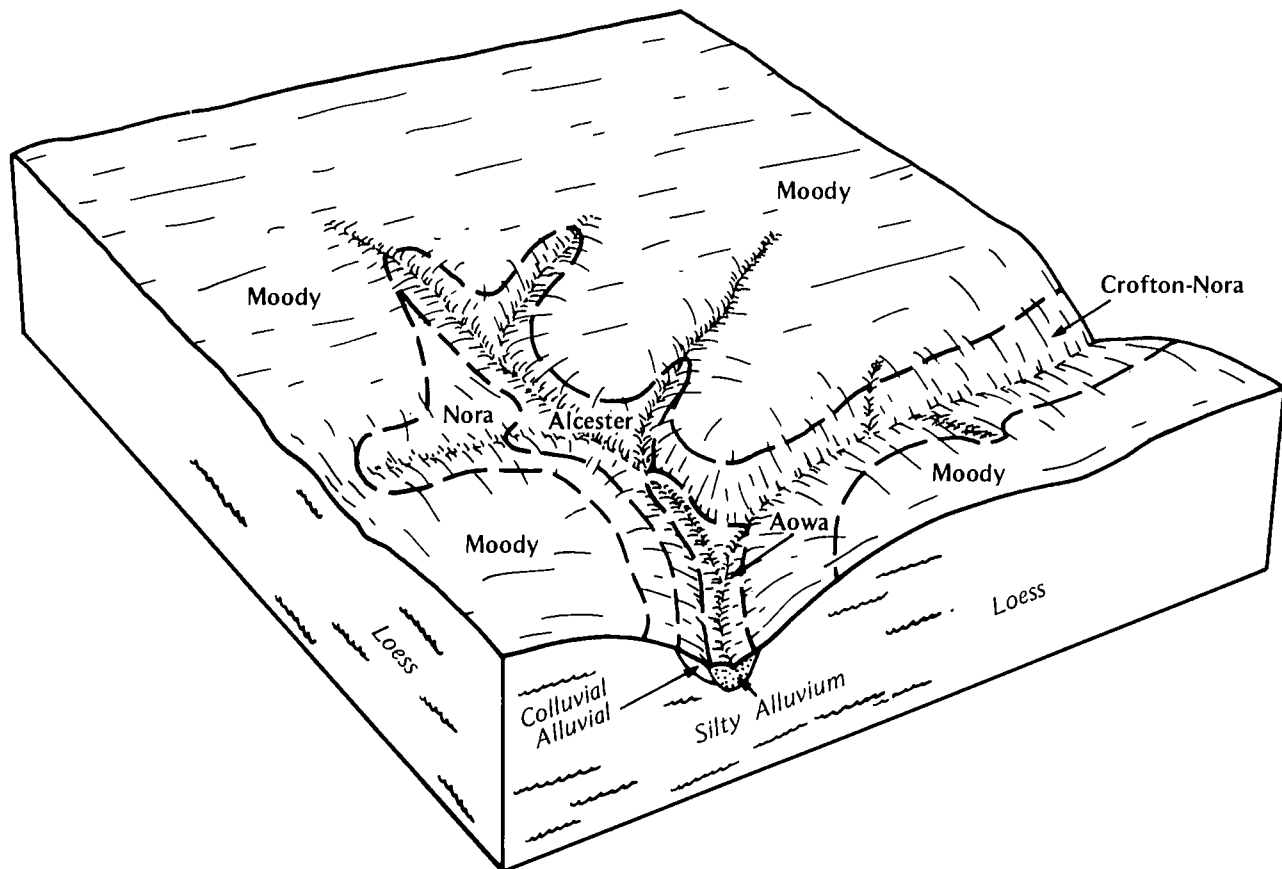


Figure 2.—Typical pattern of soils in the Moody-Nora association and the relationship of the soils to topography and parent material.

60 inches. In the upper part it is pale brown, and in the lower part it is very pale brown. The soil is calcareous throughout.

The minor soils are mainly Alcester and Nora soils. Alcester soils are similar to Eltree soils, but they do not have free carbonates in the upper part of the profile. Nora soils have darker colors to a greater depth than Crofton soils. Alcester, Nora, Eltree, and Crofton soils are on similar landscapes.

Farms in areas of this association are mainly grain and livestock enterprises. Most of the acreage is in cultivated crops. The main crops are corn, soybeans, alfalfa, and oats. About 85 percent of the acreage is dry-farmed, and about 15 percent is irrigated. Deep wells supply the irrigation water. Livestock on the farms are mainly swine, beef cattle, or dairy cattle.

Water erosion is a hazard in cultivated areas that are gently sloping to moderately steep. Conservation tillage and terraces help to control water erosion and to conserve moisture. In irrigated areas, it is necessary to apply adequate amounts of irrigation water, but the rate of application must be controlled to minimize erosion.

#### **Gently sloping to moderately steep, loamy and sandy soils on uplands**

The soils in this group are deep and well drained and somewhat excessively drained. Most of the acreage is cultivated and dry-farmed. Some of the acreage is in introduced or native grasses, and some is irrigated, mainly by a center-pivot sprinkler system. Soil blowing and water erosion are the main hazards, and insufficient available water in the soils is the main limitation. Conserving water for plant use and maintaining fertility are the main concerns in management.

#### **4. Loretto-Thurman-Ortello Association**

*Deep, gently sloping to moderately steep, well drained and somewhat excessively drained, loamy and sandy soils that formed in loess, outwash, and eolian deposits; on uplands*

This association consists mainly of well drained and somewhat excessively drained soils on dissected uplands. The slope ranges from 2 to 15 percent.

This association takes in about 90,000 acres, or 19 percent of the county. It is about 30 percent Loretto soils, 16 percent Thurman soils, 14 percent Ortello soils, and 40 percent minor soils.

Loretto soils are gently sloping and strongly sloping; they formed in loess over sand. Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsurface layer is also dark grayish brown, friable loam; it is about 8 inches thick. The subsoil is about 26 inches thick. In the upper part it is brown, friable loam, and in the lower part it is brown, friable sandy loam. The underlying material is light yellowish brown, calcareous loamy sand to a depth of more than 60 inches.

Thurman soils are gently sloping and strongly sloping; they formed in eolian material and in glacial outwash. Typically, the surface layer is very dark gray, very friable loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown, very friable loamy sand about 5 inches thick. A transitional layer is brown, very friable sand about 9 inches thick. The underlying material, to a depth of more than 60 inches, is sand that is light yellowish brown over very pale brown.

Ortello soils are gently sloping to moderately steep; they formed in eolian material. Typically, the surface layer is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is also dark grayish brown, friable sandy loam; it is about 7 inches thick. The subsoil is about 21 inches thick. In the upper part it is brown, friable fine sandy loam, and in the lower part it is pale brown, very friable loamy fine sand. The underlying material is pale brown and very pale brown loamy fine sand to a depth of more than 60 inches.

The most extensive minor soils are the well drained Blendon and Maskell soils. Other minor soils are Alcester, Betts, Crofton, and Nora soils. Alcester soils have dark colors to a depth of more than 20 inches and are on concave foot slopes. Betts soils have more clay throughout the profile and generally are in the highest positions on the landscape in the immediate area. Blendon soils have a thick, dark surface layer and subsoil; they are on alluvial fans and terraces. Crofton soils are silty throughout and do not have a dark surface layer. Crofton soils and Loretto, Thurman, and Ortello soils are in similar positions on the landscape. Maskell soils have a thick, dark surface layer and subsoil. They are loamy throughout and are on terraces, foot slopes, and alluvial fans. Nora soils are silty throughout and have a dark surface layer. They are in positions similar to those of Loretto, Thurman, and Ortello soils.

Farms in areas of this association are diversified grain and livestock enterprises. Most of the acreage is in cultivated crops. The main crops are corn, soybeans, alfalfa, and oats. About 90 percent of the acreage is dry-farmed, and about 10 percent is irrigated. Deep wells supply the irrigation water. Livestock on the farms are mainly swine, beef cattle, or dairy cattle.

Soil blowing is a hazard if the surface is not adequately protected by crops or crop residue. Water erosion is a hazard in cultivated areas that are gently sloping to moderately steep. Conservation tillage and terraces help to control water erosion and to conserve moisture. In irrigated areas, it is necessary to apply adequate amounts of irrigation water, but the rate of application must be controlled to minimize erosion.

#### **Strongly sloping to very steep, silty soils on uplands and foot slopes**

The soils in this group are deep and are well drained to excessively drained. Most of the acreage is in



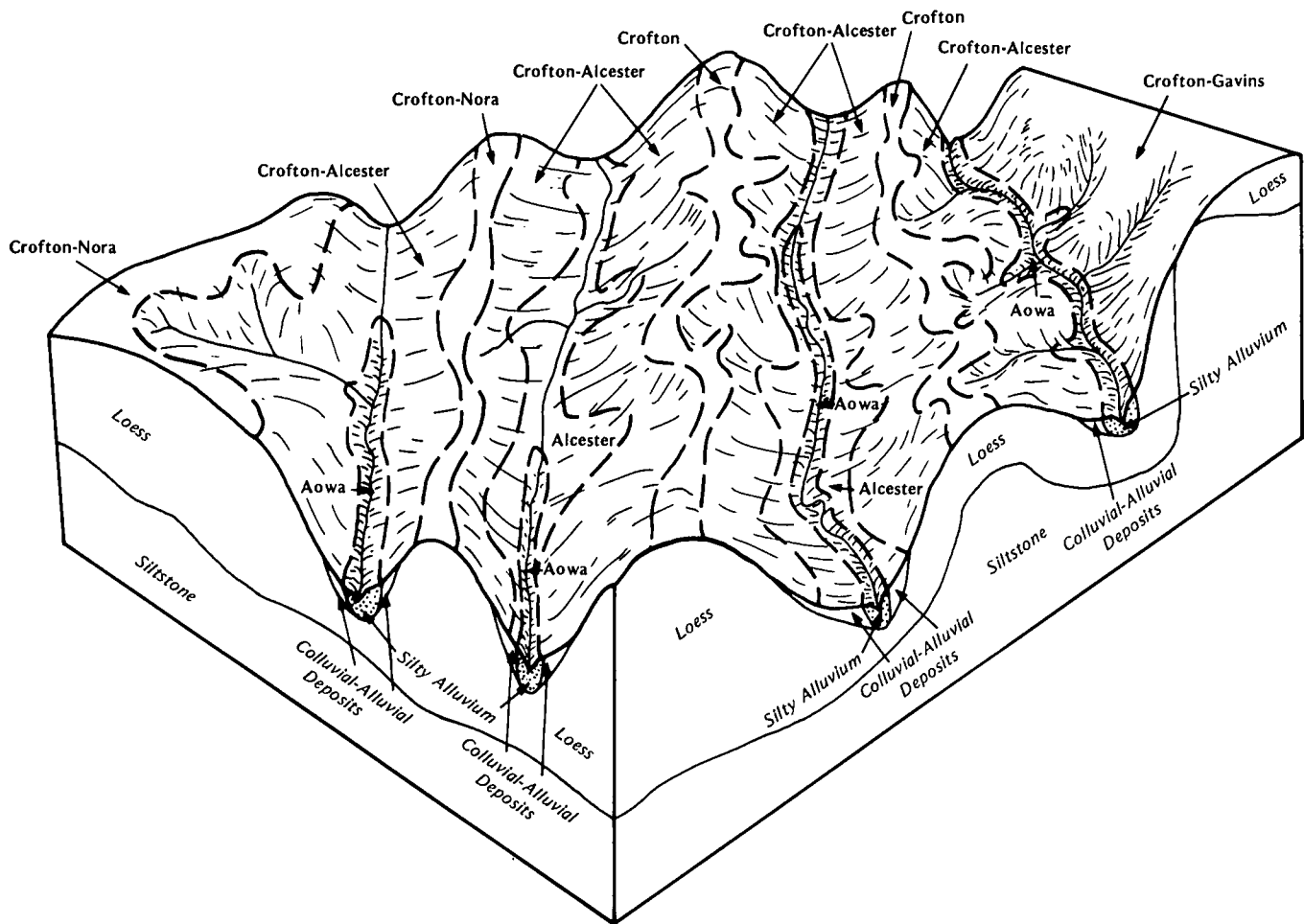


Figure 3.—Typical pattern of soils in the Crofton-Alcester association and the relationship of the soils to topography and parent material.

introduced or native grasses. Small areas of level to moderately steep soils included in this group are used for cultivated feed crops. Some areas support thick stands of bur oak and associated woody vegetation. Water erosion is the main hazard. Conserving water for plant use and maintaining soil fertility are the main concerns in cropland management. Brush control and proper grazing use are the main concerns in managing grassland.

##### 5. Crofton-Alcester Association

*Deep, strongly sloping to very steep, well drained to excessively drained, silty soils that formed in loess and colluvium; on uplands and foot slopes*

This association consists of soils on dissected uplands, ridges, side slopes, and foot slopes along intermittent drainageways (fig. 3). Slope ranges from 6 to 60 percent.

This association takes in about 47,000 acres, or 10 percent of the county. It is about 69 percent Crofton soils, 10 percent Alcester soils, and 21 percent minor soils.

Crofton soils are on upper slopes and crests of ridges. They are moderately steep to very steep and are well drained to excessively drained. Typically, the surface layer is dark grayish brown, very friable silt loam 6 inches thick. A transitional layer is brown, very friable silt loam 4 inches thick. The underlying material is silt loam to a depth of more than 60 inches. The upper part is pale brown, and the lower part is light yellowish brown. The soil is calcareous throughout.

Alcester soils are on plane or slightly concave foot slopes. They are strongly sloping to steep and are well drained. Typically, the surface layer is dark grayish brown, very friable silt loam about 6 inches thick. The subsurface layer is also dark grayish brown, very friable silt loam; it is about 8 inches thick. The subsoil is dark



**Figure 4.—Typical area of the Crofton-Alcester association. The soils in this association are mainly in native and introduced grasses that are grazed by beef cattle.**

grayish brown, friable silt loam about 22 inches thick. The underlying material is brown, calcareous silt loam to a depth of more than 60 inches.

The minor soils are Aowa, Gavins, and Nora soils. Aowa soils are on the narrow bottoms of drainageways. They are subject to flooding and commonly are cut by deep, steep-walled channels. Gavins soils are shallow over siltstone and are on steep side slopes. Nora and Crofton soils are on similar slopes. Nora soils have a subsoil of silty clay loam.

Farms in areas of this association are mainly grain and livestock enterprises. The grain is used for feeding livestock, and the rangeland is used for beef production. The level to moderately steep soils on the more uniform

landscapes generally are used for dry-farmed crops of corn and oats. The soils on side slopes, ridges, and narrow drainageways are in native grasses and are used for grazing (fig. 4). Some areas support thick stands of bur oak and associated woody vegetation.

Water erosion is the main hazard in cultivated areas. Conservation tillage and terraces help to control water erosion and to conserve moisture.

Range management that includes proper grazing use, timely deferment from grazing or haying, and a system of use and rest that changes the order each year helps to maintain or improve the range condition. Brush management may be needed to control undesirable woody plants.

### **Nearly level and very gently sloping, silty, sandy, and clayey soils on bottom lands**

The soils in this group are deep and excessively drained, well drained, and somewhat poorly drained to poorly drained. Most of the acreage is cultivated and dry-farmed. Some is irrigated, mainly by a center-pivot sprinkler system. A small acreage is in introduced or native grasses. The hazard of rare or occasional flooding and excessive wetness are the main limitations. Improving drainage and maintaining fertility are the main concerns in management.

### **6. Aowa-Shell-Hobbs Association**

*Deep, nearly level, well drained, silty soils that formed in alluvium; on bottom lands*

This association consists of soils on flood plains of intermittent and perennial streams. The slope ranges from 0 to 2 percent.

This association takes in about 47,000 acres, or 10 percent of the county. It is about 19 percent Aowa soils, 16 percent Shell soils, 15 percent Hobbs soils, and 50 percent minor soils.

Aowa soils are on flood plains of smaller drainageways. They are subject to occasional flooding. Typically, the surface layer is brown, friable silt loam about 9 inches thick. The underlying material is stratified, brown and dark grayish brown, friable silt loam to a depth of more than 60 inches. The soil is calcareous throughout.

Shell soils are on the broader flood plains of the larger drainageways. They are subject to occasional flooding. Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is about 25 inches thick. It is dark grayish brown, friable silty clay loam in the upper part and dark gray, friable silt loam in the lower part. The underlying material is silty clay loam to a depth of more than 60 inches. It is grayish brown in the upper part and dark grayish brown in the lower part.

Hobbs soils are adjacent to intermittent and perennial streams. They are subject to occasional flooding. Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The underlying material is stratified silt loam about 33 inches thick. It is dark grayish brown in the upper part, brown in the middle part, and grayish brown in the lower part. Below that, there is a buried soil that is very dark grayish brown, friable silt loam to a depth of more than 60 inches.

The most extensive minor soils are the well drained Hord and Nimbro soils. The other minor soils are Colo and Lamo soils. Colo, Lamo, and Nimbro soils are in similar positions on flood plains. Hord soils are on slightly higher terraces and are rarely flooded. They have a thick, dark surface layer and subsoil. Colo soils are somewhat poorly drained, have a thick, dark surface layer and subsoil, and are in slightly depressional areas

on the broader flood plains. Lamo soils are somewhat poorly drained and poorly drained, have a thick, dark surface layer, and are in slight depressions on broader flood plains. Nimbro soils have more sand and less silt and clay below the surface layer, and they are calcareous.

Farms in areas of this association are grain and livestock enterprises. Most of the acreage is in cultivated crops. The main crops are corn, soybeans, alfalfa, and oats (fig. 5). About 70 percent of the acreage is dry-farmed, and 30 percent is irrigated. Shallow wells and perennial streams supply the irrigation water. Livestock on the farms are mainly swine, beef cattle, or dairy cattle.

The hazard of occasional flooding is the main management problem. On upland soils, such conservation practices as conservation tillage and terraces help to prevent excessive upland runoff, which causes flooding on the soils in this association.

### **7. Sarpy-Blake-Albaton Association**

*Deep, nearly level and very gently sloping, excessively drained, somewhat poorly drained, and poorly drained, sandy, silty, and clayey soils that formed in alluvium; on bottom lands*

This association consists of soils on bottom lands of the Missouri River (fig. 6). The slope ranges from 0 to 3 percent.

This association takes in about 19,865 acres, or about 4 percent of the county. It is about 20 percent Sarpy soils, 17 percent Blake soils, 15 percent Albaton soils, and 48 percent minor soils.

Sarpy soils in most areas are nearly level and very gently sloping, but in a few areas they are gently sloping to strongly sloping. They are excessively drained. They are higher on the landscape than adjoining soils. Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 8 inches thick. The underlying material is calcareous and is grayish brown, pale brown, and light gray fine sand to a depth of more than 60 inches.

Blake soils are nearly level and are somewhat poorly drained. They are in intermediate positions on the landscape, above Albaton soils and below Sarpy soils. Typically, the surface layer is grayish brown, friable silty clay loam about 8 inches thick. The upper part of the underlying material, to a depth of about 24 inches, is stratified grayish brown silty clay loam that has distinct mottles. In the lower part, the underlying material to a depth of more than 60 inches is stratified light brownish gray silt loam that has distinct mottles. The soil is calcareous throughout.

Albaton soils are nearly level and are poorly drained. They are in the lowest positions on the landscape. Typically, the surface layer is dark gray, firm silty clay about 7 inches thick. The underlying material is stratified



Figure 5.—Typical area of the Aowa-Shell-Hobbs association. The crops shown are soybeans, in the foreground and the darker areas, and corn.

silty clay and clay to a depth of more than 60 inches. In the upper part it is dark gray and light brownish gray, and in the lower part it is gray. The underlying material has shell fragments and mottles. The soil is calcareous throughout.

The most extensive minor soils are the Grable, Onawa, and Percival soils. The other minor soils are Barney Variant and Modale soils. These soils are in similar positions. Barney Variant soils are sandy throughout, are very poorly drained, and are subject to frequent flooding. They are in the lowest positions adjacent to the Missouri River. Grable soils are silty in the upper part and sandy in the lower part. Modale soils are moderately well drained and are silty in the upper part and clayey in the lower part. Onawa soils are clayey in the upper part and silty and loamy in the lower part. Percival soils are clayey in the upper part and sandy in the lower part.

Farms in areas of this association are mainly cash-grain enterprises. Most of the acreage is used for cultivated crops. Corn, soybeans, oats, and alfalfa are the main crops. About 70 percent of the acreage is dry-farmed, and 30 percent is irrigated. Shallow wells and the Missouri River supply the irrigation water.

Excessive wetness and soil blowing are limitations to use of the soils in this association. Because of the limited available water capacity of the Sarpy and Albaton soils, drought quickly affects crops. Conservation tillage helps to conserve moisture and to prevent soil blowing. Surface and subsurface drains can be used to eliminate excessive wetness. Irrigation generally is most efficient when water is applied frequently and in relatively small amounts.

## 8. Lamo-Baltic Association

*Deep, nearly level, somewhat poorly drained and poorly drained, silty soils that formed in alluvium; on bottom lands*

This association consists of nearly level soils on bottom lands. The slope ranges from 0 to 2 percent. This association takes in about 7,530 acres, or about 1 percent of the county. It is about 45 percent Lamo soils, 24 percent Baltic soils, and 31 percent minor soils.

Lamo soils are somewhat poorly drained. Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer is also very dark gray, friable silty clay loam; it is about 12 inches thick. A transitional layer is dark gray, firm silty clay loam

about 15 inches thick. The underlying material is gray silty clay loam to a depth of more than 60 inches. The soil is calcareous throughout.

Baltic soils are poorly drained. Typically, the surface layer is very dark gray, friable silty clay loam about 6 inches thick. The subsurface layer is also very dark gray, friable silty clay loam; it is about 8 inches thick. The subsoil is firm silty clay about 26 inches thick. In the upper part it is very dark gray, and in the lower part it is gray. The underlying material is gray silty clay to a depth of more than 60 inches.

The most extensive minor soils are the well drained Shell soils. Other minor soils are Colo and Hord soils. Colo soils are on bottom lands in positions similar to those of Lamo and Baltic soils. Colo soils do not have calcium carbonates in the solum. Shell soils are well

drained and are in higher positions on flood plains. Hord soils are well drained and are on the highest terraces on flood plains; they are only rarely flooded.

Farms in areas of this association are grain and livestock enterprises. Most of the acreage is in cultivated crops. Corn, soybeans, and alfalfa are the main crops. About 85 percent of the acreage is dry-farmed, and 15 percent is irrigated. Shallow wells and Logan Creek supply the irrigation water. Livestock on the farms are beef cattle and swine.

Wetness and the hazard of occasional flooding are the main management problems. Improving surface drainage by grading or ditching and internal drainage by tiling helps to prevent excessive wetness. On upland soils, conservation tillage and terraces help to prevent

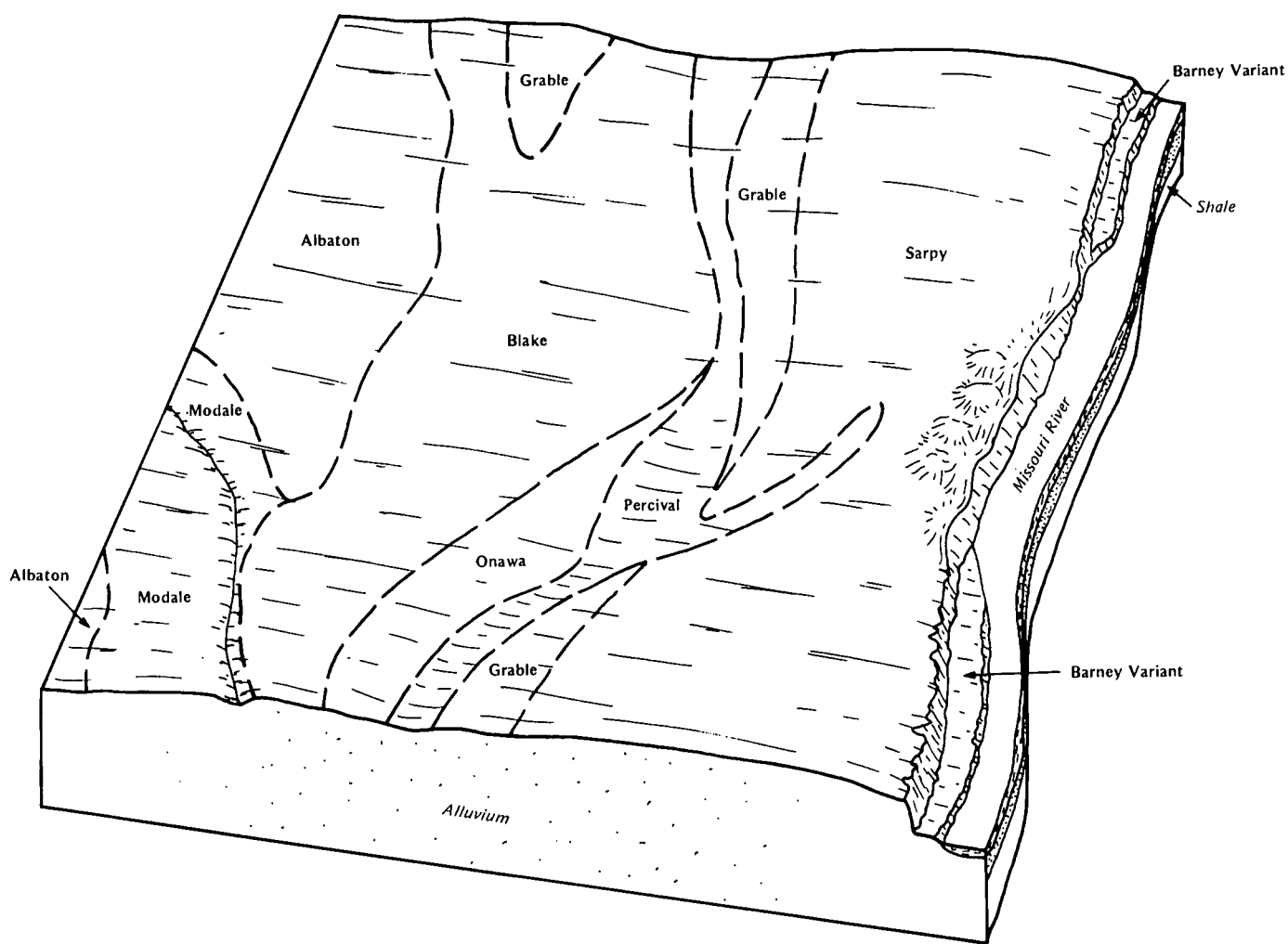


Figure 6.—Typical pattern of soils in the Sarpy-Blake-Albaton association and the relationship of the soils to topography and parent material.



excessive upland runoff, which causes occasional flooding on the soils in this association.

### **Gently sloping to steep, loamy soils on uplands**

The soils in this group are deep or shallow over sand and gravel and are well drained to excessively drained. About half of the acreage is in introduced or native grasses. About half of the acreage is cultivated and dry-farmed. Some of the acreage is irrigated, mainly by a center-pivot sprinkler system. Water erosion, soil blowing, and drought caused by the limited water holding capacity of some of the soils are the main hazards. Conserving water for plant use, maintaining fertility, and maintaining grassland in good or excellent condition are important concerns in management.

### **9. Betts-Ortello-Talmo Association**

*Deep, gently sloping to steep, well drained to excessively drained, loamy soils that formed in glacial till or in eolian material and outwash deposits; on uplands*

This association consists of soils on uplands. The slope ranges from 2 to 30 percent.

This association takes in about 24,885 acres, or 5 percent of the county. It is about 49 percent Betts soils, 14 percent Ortello soils, 9 percent Talmo soils, and 28 percent minor soils.

Betts soils are strongly sloping to steep and are well drained and somewhat excessively drained. They formed in glacial till. Typically, the surface layer is grayish brown, firm clay loam about 4 inches thick. The subsoil is grayish brown, firm clay loam about 5 inches thick. The underlying material is light yellowish brown and light brownish gray clay loam to a depth of more than 60 inches. The soil is calcareous throughout.

Ortello soils are gently sloping to moderately steep and are well drained. They formed in eolian deposits. Typically, the surface layer is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsoil is about 21 inches thick. It is brown, friable fine sandy loam in the upper part and pale brown, very friable loamy fine sand in the lower part. The underlying material is pale brown and very pale brown loamy fine sand to a depth of more than 60 inches.

Talmo soils are gently sloping to steep and are excessively drained. They formed in loamy and sandy material over sand and gravel. Typically, the surface layer is very dark grayish brown, very friable, gravelly coarse sandy loam about 9 inches thick. A transitional layer, which is about 11 inches thick, is very dark grayish brown, loose, gravelly loamy coarse sand in the upper part and brown, loose, very gravelly coarse sand in the lower part. The underlying material is yellowish brown, gravelly coarse sand over coarse sand in the upper part and pale brown coarse sand in the lower part to a depth of more than 60 inches.

The minor soils are Boyd, Loretto, Simeon, and Thurman soils. Boyd soils are clayey throughout and formed in residuum of shale. They generally are in the highest positions in the immediate area. Loretto soils are loamy and deep. They are on the more uniform, broader divides and less steep side slopes. Simeon soils are deep and excessively drained and do not have a dark surface layer. They and Talmo soils are in similar positions on the landscape. Thurman soils are sandy throughout. They and Ortello soils are in similar positions on the landscape.

Farms in areas of this association are grain and livestock enterprises. About 50 percent of the acreage is in cultivated crops, and 50 percent is used as range or pasture. The main crops are corn, soybeans, alfalfa, and oats. About 80 percent of the cultivated acreage is dry-farmed, and about 20 percent is irrigated. Deep wells supply the irrigation water. Livestock on the farms are mainly swine, beef cattle, or dairy cattle.

Water erosion and droughtiness caused by the limited water-holding capacity of some of the soils are hazards in cultivated areas. Conservation tillage and terraces help to control water erosion and to conserve moisture. In irrigated areas, it is necessary to apply adequate amounts of irrigation water, but the rate of application must be controlled to minimize erosion.

### **Nearly level to steep, moderately deep and shallow soils on uplands**

The soils in this group are moderately deep and shallow and are well drained and somewhat excessively drained. Most of the acreage is cultivated and dry-farmed. Some of the acreage is in introduced and native grasses. A small acreage is irrigated, mainly by sprinkler systems. Water erosion and droughtiness caused by the insufficient water-holding capacity of the soils are the main hazards. Conserving water for plant use and maintaining native grassland in good or excellent condition are the main concerns in management.

### **10. Redstoe-Gavins Association**

*Moderately deep and shallow, nearly level to steep, well drained and somewhat excessively drained, silty soils that formed in residuum of siltstone; on uplands*

This association consists of soils on uplands. The slope is mainly 0 to 11 percent, but the range is from 0 to 30 percent.

This association takes in about 21,770 acres, or about 4 percent of the county. It is about 55 percent Redstoe soils, 18 percent Gavins soils, and 27 percent minor soils.

Redstoe soils are moderately deep, nearly level to strongly sloping, and well drained. Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is also very dark grayish brown, friable silt loam; it is about 4 inches thick.



A transitional layer is grayish brown, friable silt loam about 6 inches thick. The underlying material is very pale brown, friable silt loam about 6 inches thick. Soft, chalky siltstone is at a depth of about 27 inches. The soil is calcareous throughout.

Gavins soils are shallow, strongly sloping to steep, and well drained or somewhat excessively drained. Typically, the surface layer is grayish brown, very friable silt loam about 6 inches thick. A transitional layer is pale brown, very friable silty clay loam about 3 inches thick. The underlying material is very pale brown, friable silty clay loam. Soft, calcareous siltstone is at a depth of 14 inches. The soil is calcareous throughout.

The minor soils are Boyd and Betts soils and the bedrock substratum phase of Hord soils. Boyd soils are clayey throughout and formed in residuum of shale. They are in the highest positions on the landscape. Betts soils

are deep, are loamy throughout, and formed in glacial till. They are in the highest positions on the landscape. Hord, bedrock substratum, soils are deep and are on nearly level uplands and terraces.

Farms in areas of this association are mainly grain and livestock enterprises. Most of the acreage is in cultivated crops, but some is used as range or pasture. Corn, alfalfa, and oats are the main crops. The acreage is mainly dry-farmed. Livestock on the farms are mainly swine, beef cattle, and dairy cattle.

Water erosion is the main hazard in cultivated areas. Droughtiness, which is caused by the limited water-holding capacity of the shallow and moderately deep soils, is an important concern in management. Conservation tillage helps to control water erosion and to conserve moisture.



# Detailed Soil Map Units

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The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Moody silty clay loam, 0 to 2 percent slopes is one of several phases in the Moody series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Crofton-Nora complex, 2 to 6 percent slopes, eroded is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included

soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, Sand and Gravel is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Some soil boundaries and soil names may not match those in adjoining areas in adjacent counties that were published at an earlier date. This is a result of changes and refinements in series concepts, different slope groupings, and application of the latest soil classification system.

## Soil Descriptions

**Aa—Albaton silty clay, 0 to 2 percent slopes.** This is a deep, nearly level, poorly drained soil on bottom lands of the Missouri River. The soil formed in clayey sediment. It is subject to rare flooding. The areas of this soil range from 75 to 650 acres in size.

Typically, the surface layer is dark gray, firm silty clay about 7 inches thick. The underlying material is stratified silty clay and clay to a depth of more than 60 inches. It is dark gray and light brownish gray in the upper part and gray in the lower part. There are shell fragments and mottles in the underlying material. The soil is calcareous throughout. In some areas the surface layer is silty clay loam or clay. In some areas the underlying material is silty clay loam in some or all subhorizons.

Included with this soil in mapping are small areas of Onawa and Percival soils. Onawa soils are loamy below a depth of 18 to 30 inches, and Percival soils are sandy below a depth of 15 to 30 inches. They are in slightly higher positions. The included soils make up 5 to 15 percent of the map unit.

Permeability is slow. The available water capacity is moderate. Runoff is slow. The organic matter content is moderate. Tilth is poor, and the soil is difficult to till because of the clayey texture. The shrink-swell potential

is high throughout. The water intake rate is very low. The seasonal high water table ranges from a depth of about 1 foot in wet years to about 3 feet in dry years.

Most of the acreage of this soil is dry-farmed. A few areas are irrigated.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. The major limitations are excessive soil wetness and poor tilth, which sometimes delay spring tillage, and the moderate available water capacity. Excessive soil wetness can be overcome by land leveling and by ditching for surface drainage if outlets are available. Tilth can be improved by incorporating crop residue into the soil and by tilling only when the soil moisture is optimum. Crop stress during drought is compounded by the moderate available water capacity and because the soil cracks as it dries out. The cracking injures plant roots and accelerates drying. Cultivation reduces cracking and fills the cracks. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn and soybeans. Gravity irrigation systems are suited to this soil, but a sprinkler irrigation system does not work well. Land leveling helps to improve surface drainage and increases the efficiency of an irrigation system. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Timely application of water is critical to efficient water management. The soil needs to be wet nearly to maximum field capacity at the beginning of the period of maximum water use to avoid crop stress.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and wildlife. Survival of adapted species is good. Cracking in summer because of the high shrink-swell potential of the soil and competition for moisture from weeds and grasses are the major hazards. The cracks can be closed by light cultivation and supplemental watering. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition can also be controlled by careful use of appropriate herbicides in the rows. Areas in the rows or near small trees can be hoed by hand or rototilled.

This soil generally is not suited to use as septic tank absorption fields because of wetness, the hazard of rare flooding, and the slow permeability. An alternate site should be considered. This soil generally is not suited to

use as building sites because of flooding, wetness, and the high shrink-swell potential. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. The upper part of the soil can be replaced or covered with a coarse base material, such as sand or gravel. The base material can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This soil is in capability unit IIIw-1, dryland and irrigated; in the Clayey Overflow range site; and in windbreak suitability group 2W.

**Ab—Albaton silty clay, ponded, 0 to 2 percent slopes.** This is a deep, nearly level, very poorly drained soil in depressions on bottom lands of the Missouri River. The soil formed in clayey sediment. It is subject to frequent ponding of very long duration. The areas of this soil range from 5 to 45 acres in size.

Typically, the surface layer is gray, firm silty clay about 8 inches thick. The underlying material is gray silty clay to a depth of more than 60 inches. The soil is calcareous and mottled throughout. Small areas around the perimeter of the mapped areas, in the highest positions on the landscape, are slightly better drained. In some areas there are silty clay loam or silt loam subhorizons in the profile.

Permeability is slow. The available water capacity is moderate. Runoff is slow to ponded. The organic matter content is moderate. Tilth is poor. The shrink-swell potential is high throughout. The water intake rate is very low. The seasonal high water table ranges from 6 inches above the surface in wet years to a depth of 2 feet in dry years.

Most of the acreage of this soil is idle or unused land. The native vegetation consists of rushes and water-tolerant grasses, shrubs, and trees. Weeds generally flourish if the soil is cultivated.

This soil is not suited to cultivated crops or pasture, either dry-farmed or irrigated. The high water table, wetness, slow runoff, and ponding are limitations. The soil generally is not suited to trees and shrubs in windbreaks. The high water table, wetness, and frequent ponding are limitations to this use. This soil generally is suited to use as habitat for wetland wildlife.

This soil is not suited to use as septic tank absorption fields or as building sites. Flooding, ponding, slow permeability, and the high shrink-swell potential are limitations. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse-grained base material, such as sand or gravel. Constructing roads on suitable, well compacted fill material above the ponding level and constructing adequate side ditches and culverts help to protect roads from damage caused by ponding and wetness from the seasonal high water table.

This soil is in capability unit Vw-1, dryland, and in windbreak suitability group 10. It was not assigned to a range site.

**AcC—Alcester silt loam, 2 to 6 percent slopes.** This is a deep, gently sloping, well drained soil on upland foot slopes. The soil formed in silty colluvium. The areas of this soil range from 5 to 600 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is dark grayish brown, and the lower part is brown. The underlying material is brown silt loam and silty clay loam to a depth of more than 60 inches. In some places the surface layer is lighter colored and the soil is calcareous in the upper 12 inches.

Included with this soil in mapping are small areas of Aowa, Hord, and Moody soils. Aowa soils border the small upland drainageways that intersect areas of the Alcester soil. They are subject to occasional flooding and are stratified and calcareous. Hord soils are in adjacent lower positions that are subject to rare flooding. Moody soils are on side slopes above the Alcester soil. They have dark colors to a depth of less than 20 inches. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Moisture is readily released to plants. Runoff is medium. The organic matter content is high. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is farmed, mainly dry-farmed. Some areas are irrigated. A few small areas are in introduced grasses or native grasses.

Under dryland management, this soil is suited to corn, soybeans, oats, and alfalfa. Water erosion is the main hazard. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the soil surface, helps to control erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Terraces and grassed waterways help to control erosion.

Under irrigation, this soil is suited to corn, soybeans, oats, and alfalfa. A sprinkler irrigation system works well on this soil. The main hazard is water erosion. Adjusting the application rate of water to the moderate intake rate of the soil helps to prevent excessive runoff and to control erosion. Conservation tillage, such as no-till, which keeps all or most of the crop residue on the surface, helps to control erosion and to conserve moisture. Returning crop residue to the soil and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to introduced or domesticated grasses for pasture. Pasture can be alternated with crops as part of a crop rotation. Most pastures consist of such cool-season grasses as smooth brome, alone or mixed with alfalfa, but some consist of orchardgrass and alfalfa. Overgrazing, which causes low plant vigor, can result in the formation of small gullies and rills after heavy rains. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Proper stocking rates and rotation grazing help to maintain the grasses in good condition. Nitrogen and phosphate fertilizers increase the growth and vigor of the grasses.

This soil is suited to use as rangeland and native hayland. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, indiangrass, sideoats grama, switchgrass, and western wheatgrass. If the range site is overgrazed or hayed at an improper time, the site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the area; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Tillage or chemical methods are effective in preparing a favorable site for plantings. Weeds can be controlled by cultivation between the rows, by hand hoeing within the rows of trees, or by careful use of appropriate herbicides. Newly planted trees may need supplemental watering during periods of insufficient rainfall.

This soil generally is suited to use as septic tank absorption fields. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage caused by the shrinking and swelling of the soil. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse-grained base material, such as sand or gravel. Crowning the roadbed by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IIe-1, dryland, and IIle-6, irrigated; in the Silty range site; and in windbreak suitability group 3.

**AcD—Alcester silt loam, 6 to 11 percent slopes.**

This is a deep, strongly sloping, well drained soil on upland foot slopes along small drainageways. The soil formed in silty colluvium. The slopes are short and

concave. The areas of this soil range from 5 to 550 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 6 inches thick. The subsurface layer is also dark grayish brown, very friable silt loam; it is about 8 inches thick. The subsoil is dark grayish brown, friable silt loam about 22 inches thick. The underlying material is brown, calcareous silt loam to a depth of more than 60 inches. In some places the surface layer is lighter colored and the upper 12 inches of the soil is slightly calcareous.

Included with this soil in mapping are small areas of Moody soils. Moody soils are on slopes above the Alcester soil and have dark colors to a depth of less than 20 inches. The included soils make up about 15 percent of the map unit.

Permeability is moderate, and the available water capacity is high. Moisture is readily released to plants. The organic matter content is high. Runoff is medium. Tilth is good. The water intake rate is moderate.

About half the acreage of this soil is in native or introduced grasses. About half is farmed, mainly dry-farmed. Some areas are irrigated. Some areas are in native trees.

Under dryland management, this soil is suited to corn, soybeans, oats, and alfalfa. Water erosion is the main hazard. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Terraces, contour farming, grassed waterways, and crop rotations help to control erosion and to conserve water.

Under irrigation, this soil is suited to alfalfa and small grains. It is poorly suited to such row crops as corn and soybeans. The major hazard is water erosion. A sprinkler irrigation system works well on this soil. Adjusting the application rate of water to the moderate intake rate of the soil helps to prevent excessive runoff and to control erosion. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve moisture. Returning crop residue to the soil and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Contour farming, terraces, and grassed waterways help to control erosion.

This soil is suited to introduced or domesticated grasses for pasture. Pasture can be alternated with crops as part of a crop rotation. Most pastures consist of such cool-season grasses as smooth brome, alone or mixed with alfalfa, but some consist of orchardgrass and alfalfa. Overgrazing, which causes low plant vigor, results in the formation of small gullies and rills after heavy rains. Separate pastures of cool- and warm-season

grasses can provide a long season of grazing. Proper stocking rates and rotation grazing help to maintain the grasses in good condition. Nitrogen and phosphate fertilizers increase the growth and vigor of the grasses.

This soil is suited to use as rangeland and native hayland. This use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, indiangrass, sideoats grama, switchgrass, and western wheatgrass. If the range is overgrazed or is hayed at an improper time, the site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the area; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Tillage or chemical methods are effective in preparing a favorable site for plantings. Weeds can be controlled by cultivation between the rows, by hand hoeing, or by careful use of appropriate herbicides within the rows. Erosion can be controlled by planting trees on the contour in combination with terraces. Newly planted trees may need supplemental watering during periods of insufficient rainfall.

Land shaping and installing a septic tank absorption field on the contour generally are necessary for proper operation of the absorption field. Foundations for buildings need to be strengthened and backfilled with coarse material; thus, damage caused by the shrinking and swelling of the soil is prevented. Buildings should be constructed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and subbase are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse-grained subgrade or base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads is reduced or prevented.

This soil is in capability units 11le-1, dryland, and 11le-6, irrigated; in the Silty range site; and in windbreak suitability group 3.

**Ao—Aowa silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on bottom lands. The soil formed in silty alluvium. It is subject to occasional flooding, usually late in winter and early in spring. The areas of this soil range from 10 to 250 acres in size.

Typically, the surface layer is brown, friable silt loam about 9 inches thick. The underlying material is stratified brown and dark grayish brown silt loam to a depth of more than 60 inches. The soil is calcareous throughout.

In some small areas the soil is not calcareous, and in some areas there are strata slightly higher in sand content within a depth of 60 inches. Some small areas have mottles at a depth below 40 inches. In some areas there is stratification within a depth of 10 inches of the soil.

Included with this soil in mapping are small areas of Alcester and Kezan soils. Alcester soils are not stratified and are in higher positions than the Aowa soil. Kezan soils are poorly drained and are in lower positions. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed, and some is irrigated. Most of the remainder is pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Occasional flooding is the main hazard. The flooding seldom damages crops. Flooding can be reduced by retaining precipitation on upland soils. Terraces, diversions, and conservation tillage help to retain precipitation and to reduce runoff from upland soils. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. In some places leveling may be required for gravity systems. Flooding is the main hazard. Flooding seldom damages crops. Flooding can be reduced by retaining precipitation on upland soils. Terraces, diversions, and conservation tillage help to retain precipitation on upland soils and to control runoff. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve organic matter content and soil fertility and to increase the infiltration of water.

This soil is suited to introduced grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most commonly grown grass is smooth brome. Sediment deposited by floodwater may partly cover the grasses and reduce their vigor and growth. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Adapted species usually survive and grow well.

Competition for moisture from weeds and grasses is the major hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition in the rows can be controlled by hand hoeing, rototilling, and the use of appropriate herbicides.

This soil is not suited to use as septic tank absorption fields and as building sites because of flooding. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material, such as sand or gravel. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage. Crowning the roads by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units 1lw-3, dryland, and 1lw-6, irrigated; in the Silty Overflow range site; and in windbreak suitability group 1.

**Ap—Aowa silt loam, channeled.** This is a deep, nearly level, well drained soil on bottom lands. The areas are dissected by entrenched channels that are generally not crossable with conventional farm equipment. The channels are 25 to 80 feet wide and 3 to 20 feet deep. The soil formed in silty alluvium. It is subject to frequent, brief flooding. The areas are long and narrow. The areas of this soil range from 5 to 360 acres in size.

Typically, the surface layer is stratified grayish brown and pale brown, friable silt loam about 7 inches thick. The underlying material is stratified, very friable silt loam to a depth of more than 60 inches. It is grayish brown and pale brown in the upper part and light brownish gray and brown in the lower part. In some areas the soil is not calcareous. In some areas there are strata or lenses of contrasting textures in the profile.

Included with this soil in mapping are small areas of Alcester, Inavale, and Kezan soils. Alcester soils are not subject to flooding and are in the highest positions adjacent to steeper upland soils. Inavale soils and the Aowa soil are in similar positions on the landscape, but Inavale soils are sandy. Kezan soils are poorly drained and are in slightly higher positions on the landscape than those of the Aowa soil. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good.

Most of the acreage of this soil is used as pasture and rangeland.

This soil is not suited to cultivated crops. It is dissected by entrenched drainageway channels that are too steep and rough to cross with most farm equipment. Also, streambanks can be undercut and eroded when streamflow is high.

This soil is suited to introduced grasses for pasture. Such cool-season grasses as smooth brome or orchardgrass are suitable, either alone or mixed with legumes, such as alfalfa, or with warm-season grasses, such as switchgrass or big bluestem. Sediment deposited by floodwaters may partly cover the grasses and reduce their vigor and growth. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

The soil is suited to use as rangeland and native hayland. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and western wheatgrass. If an area is overgrazed or is hayed at an improper time, the site may be dominated by western wheatgrass, Kentucky bluegrass, and numerous annual and perennial broadleaf weeds. Also, woody plants may migrate to the area; these include snowberry and buckbrush. Brush management and prescribed burning may be needed to control the woody plants.

This soil is not suited to trees and shrubs in windbreaks or to plantings for recreation use and for wildlife. The survival and growth rates even of adapted species are poor. Some areas can be used for wildlife habitat or for recreation use if adapted trees or shrubs are planted by hand.

This soil is not suited to use as septic tank absorption fields and as building sites because of flooding. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material, such as sand or gravel. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability unit Vlw-7, dryland, in the Silty Overflow range site, and in windbreak suitability group 10.

#### **Ba—Baltic silty clay loam, 0 to 2 percent slopes.**

This is a deep, nearly level, poorly drained soil on slightly depressional bottom lands. It is subject to occasional, brief flooding in spring. The soil formed in silty and clayey alluvium. The areas of this soil generally range from 50 to 950 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 6 inches thick. The subsurface layer

is also very dark gray, friable silty clay loam; it is about 8 inches thick. The subsoil is firm silty clay about 26 inches thick. In the upper part it is very dark gray, and in the lower part it is gray. The underlying material is gray, mottled silty clay to a depth of more than 60 inches. In a few areas calcium carbonates have been leached to a depth of about 18 inches. Also, in a few areas the surface layer is floodwater sediment, consisting of silt loam, as much as 10 inches thick. In a few areas the soil has slightly less clay throughout or is somewhat poorly drained.

Included with this soil in mapping are small areas of Shell soils. Shell soils are well drained, have less clay throughout the profile, and are in the highest positions. The included soils make up about 5 percent of the map unit.

Permeability is slow. The available water capacity is moderate. Runoff is slow. The organic matter content is high. Tilth is fair, and moisture content is critical to tilth. This soil can be cultivated within only a narrow range of moisture content without excessive compaction. The shrink-swell potential is moderate in the surface layer and is high in the subsoil and underlying material. The water intake rate is very low. The seasonal high water table ranges from near the surface in wet years to a depth of about 2 feet in dry years.

Most of the acreage of this soil is cultivated, under both dryland management and irrigation. A few areas are in pasture.

Under dryland management, this soil is suited to corn and soybeans. The main hazard is flooding. The main limitation is wetness, which sometimes delays spring tillage, but not so long as to miss optimum planting dates. Tiles or ditches can be used to remove excess water; outlets are generally accessible. Conservation tillage, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses in the cropping system help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn and soybeans. Both gravity and sprinkler irrigation systems work well on this soil. Land leveling helps to improve surface drainage and to increase the efficiency of an irrigation system. Conservation tillage, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Because the water intake rate of this soil is very low, transpiration and evaporation can exceed the intake, causing a water deficit and eventual crop stress. Consequently, the timing, frequency, and amount of



applications of irrigation water are critical in efficient water management.

This soil is suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing or improper haying methods reduce productivity and damage the protective cover. In addition, overgrazing or grazing when the soil is wet causes soil compaction and poor tilth. Rotation grazing and fertilization are needed for highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to trees and shrubs in windbreak plantings and to plantings for recreation use and for wildlife. The survival rate is good and the growth rate is fair for adapted species that tolerate occasional wetness. Competition for moisture from weeds and grasses is the main limitation. Plant competition can be controlled by good site preparation prior to planting through tillage or chemical methods. Plant competition between the rows can be controlled by timely cultivation with conventional equipment and in the rows by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled. In summer cracks form in the soil, caused by the high shrink-swell potential; the cracks injure roots and accelerate drying of the soil. A light cultivation and supplemental watering can close the cracks.

This soil is not suited to use as septic tank absorption fields and as building sites. The limitations are flooding, slow permeability, and wetness. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material, such as sand or gravel. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage and from wetness caused by the seasonal high water table.

This soil is in capability unit IIIw-1, dryland and irrigated, in the Clayey Overflow range site, and in windbreak suitability group 2W.

**Bb—Barney Variant fine sand, 0 to 2 percent slopes.** This is a deep, nearly level, very poorly drained soil on bottom lands. It formed in sandy alluvium. It is subject to frequent flooding. The areas of this soil range from 5 to 250 acres in size.

Typically, the surface layer is light brownish gray, mottled, loose fine sand about 4 inches thick. The underlying material is fine sand to a depth of 60 inches. It is mottled, light brownish gray in the upper part and light gray in the lower part. The soil is calcareous throughout. In some areas the surface layer is silt loam,

sandy loam, fine sandy loam, or loamy fine sand. In some areas the surface layer is dark colored. In some areas the subhorizons in the underlying material include sandy loam, loam, silt loam, and coarse sand.

Included with this soil in mapping are small areas of sandbars. These areas are mainly adjacent to the channels, are in the lowest positions, and generally do not have vegetation. The included soils make up about 5 percent of the map unit.

Permeability is rapid. The available water capacity is low. The water table usually is close to the rooting depth. Runoff is slow. The organic matter content is low. The seasonal high water table is stabilized somewhat by Gavins Point Dam; it usually is at a depth of 0 to 1.5 feet in most years.

All the acreage of this soil is covered by cattails, willows, rushes, and other aquatic vegetation. The areas of this soil provide good habitat for aquatic wildlife and waterfowl.

This soil is not suited to use as septic tank absorption fields, as building sites, and as sites for local roads. Alternate sites should be considered.

This soil is in capability unit VIIIw-7, dryland, and in windbreak suitability group 10. It was not assigned to a range site.

**BeE—Betts clay loam, 6 to 15 percent slopes.** This is a deep, strongly sloping and moderately steep, well drained soil on uplands. The soil formed in glacial till. The areas range from 5 to 625 acres in size.

Typically, the surface layer is grayish brown, firm clay loam about 4 inches thick. The subsoil is also grayish brown, firm clay loam; it is about 5 inches thick. The underlying material is light yellowish brown and light brownish gray clay loam to a depth of more than 60 inches. This soil is calcareous throughout. In some areas, the surface layer is more than 5 inches thick. In most areas pebbles and small stones are scattered on the surface and throughout the profile. In a few areas the depth to calcium carbonates is as much as 20 inches. In a few areas there are lenses of contrasting textures.

Included with this soil in mapping are small areas of Alcester, Crofton, Moody, and Ortello soils. Alcester and Moody soils are in the lowest concave positions. They formed in silt deposits. Crofton and Ortello soils and the Betts soil are in similar positions on the landscape. Crofton soils, however, formed in silt deposits and Ortello soils in loamy eolian material. In a few areas stones and boulders are common. Most are on the surface. In some places the stones and boulders are numerous or large enough to hinder or restrict machinery. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. The available water capacity is high. Runoff is medium.

The organic matter content is moderately low. Tilth is good. The water intake rate is low.

About half of the acreage of this soil is farmed, mainly dry-farmed. A few areas are irrigated. The rest of the acreage is used as pasture and range.

Under dryland management, this soil is poorly suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface layer. Conservation tillage also helps to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, also help to control water erosion. Returning crop residue to the soil and applying manure improve the tilth, increase the organic matter content, and improve the rate of water intake. A cropping system that includes grasses and legumes also helps to control water erosion and to maintain or to increase soil productivity.

Under irrigation, this soil is poorly suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. The main hazard is water erosion. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface layer. Conservation tillage helps to control water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, also help to control water erosion. Returning crop residue to the soil and applying manure improve the tilth, increase the organic matter content, and improve the rate of water intake. A cropping system that includes grasses and legumes also helps to control water erosion and to maintain or to increase soil productivity. Careful application of water is needed to prevent loss of soil productivity and crop damage through water erosion. Adjusting the application rate of water to the intake rate of the soil helps to control excessive runoff and erosion.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity and damage the protective plant cover. The slope of this soil intensifies the hazard of water erosion, and if the plant cover is poor and impaired in vigor, small gullies and rills are common after heavy rains. Management practices, such as rotation grazing and fertilization, are needed to achieve highest forage production. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to use as rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass,

and sideoats grama. If the range is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the range site; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation can supplement moisture during periods of insufficient rainfall. Plant competition can be controlled by site preparation using tillage or nonselective herbicides prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields. This limitation, however, can generally be overcome by increasing the size of the absorption field. On the steepest sites, land shaping and installing the septic tank absorption field on the contour generally are necessary for proper operation. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Buildings need to be designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be replaced or covered with a coarse base material.

This soil is in capability units IVE-9, dryland, and IVE-3, irrigated; in the Limy Upland range site; and in windbreak suitability group 8.

#### **BeF—Betts clay loam, 15 to 30 percent slopes.**

This is a deep, steep, somewhat excessively drained soil on uplands. The soil formed in glacial till. The areas of this soil range from 5 to 65 acres in size.

Typically, the surface layer is dark gray, friable clay loam about 4 inches thick. The subsoil is light brownish gray, friable clay loam about 5 inches thick. The underlying material is light gray over pale yellow clay loam to a depth of more than 60 inches. The soil is calcareous throughout. In some areas the slope is slightly less than 15 percent or slightly more than 30 percent. In a few areas the surface layer is loam and is as much as 12 inches thick. In a few areas the depth to calcium carbonates is as much as 18 inches.

Included with this soil in mapping are small areas of Alcester, Boyd, and Talmo soils. Alcester soils are in the lowest concave positions and formed in silty colluvium.

Boyd soils formed in residuum of random outcrops of shale that were never covered by glacial till or that were thinly covered but subsequently exposed. Talmo soils and the Betts soil are in similar positions, but Talmo soils are sandy. In small scattered areas, stones and boulders are common; they are mainly on the surface. In some places the stones and boulders are numerous or large enough to hinder or restrict machinery. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. The available water capacity is high. Runoff is rapid. The content of organic matter is moderately low. Tilth is fair.

Nearly all the acreage of this soil is used as pasture or rangeland.

This soil is not suited to dryland or irrigated farming.

This soil is suited to introduced grasses for pasture. This use is effective in controlling water erosion. The most common grass is smooth brome. The soil is subject to water erosion. Overgrazing by livestock or improper haying methods cause poor plant vigor and reduce the protective cover. As a result, small gullies and rills are common after heavy rains. Management practices, such as rotation grazing and fertilization, are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to use as rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the range site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the range site; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management may be needed to control woody plants.

This soil is not suited to trees and shrubs in windbreaks. In some places trees and shrubs can be planted if hand planting, special site preparation, or other special treatments are used.

This soil generally is not suited to sanitary facilities because of the steep slopes and the moderately slow permeability. An alternate site should be considered. Buildings need to be properly constructed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material. Cutting and filling generally are needed to provide a suitable grade for roads and streets.

This soil is in capability unit Vle-9, dryland, in the Limy Upland range site, and in windbreak suitability group 10.

#### **Bk—Blake silty clay loam, 0 to 2 percent slopes.**

This is a deep, nearly level, somewhat poorly drained soil on bottom lands of the Missouri River. The soil formed in silty and loamy alluvium. It is subject to rare flooding. The areas of this soil range from 10 to 800 acres in size.

Typically, the surface layer is grayish brown, friable silty clay loam about 8 inches thick. The upper part of the underlying material, to a depth of about 24 inches, is stratified grayish brown silty clay loam that has distinct mottles. The lower part is stratified light brownish gray silt loam that has distinct mottles. The soil is calcareous throughout. In some small areas the texture in the surface layer or throughout the profile is silt loam. In some small areas the lower part of the underlying material is silty clay loam that has a clay content of more than 35 percent. Some areas are better drained.

Included with this soil in mapping are small areas of Grable, Modale, Onawa, and Percival soils, which are in similar positions on the landscape. Grable soils are sandy in the lower part of the profile. Modale soils are clayey in the lower part of the profile. Onawa and Percival soils have more clay in the upper part of the profile, and Percival soils are sandy in the lower part. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. The seasonal high water table ranges from a depth of about 2 feet in wet years to about 4 feet in dry years. Tilth is good. The soil is easily tilled within a fairly wide range of moisture content. The water intake rate is low.

Most of the acreage of this soil is farmed. About half is dry-farmed, and half is irrigated. A small acreage is used as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, alfalfa, and oats. Both gravity and sprinkler irrigation systems are suited to this soil. In some places leveling may be required for gravity systems. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Adjusting the application rate of water to the water intake rate of the soil increases the efficiency of water use.

This soil is suited to introduced or domesticated grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. Nitrogen fertilizer increases growth and vigor of the grasses.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival rate for adapted species is good. The main limitation is the high calcium carbonate content of the soil. Trees and shrubs that tolerate excess calcium carbonate should be selected. Competition for moisture from weeds and grasses can be controlled by good site preparation prior to planting and by timely cultivation between the rows with conventional equipment. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled.

Septic tank absorption fields can be constructed on fill material so that the absorption field can be placed at a sufficient height above the seasonal high water table. Buildings need to be constructed on elevated, well compacted fill material to overcome the hazard of flooding and wetness caused by the high water table. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage and placing a gravel moisture barrier in the subgrade. Surface drainage is provided by crowning the road by grading and constructing adequate side ditches.

This soil is in capability units I-1, dryland, and I-3, irrigated; in the Silty Lowland range site; and in windbreak suitability group 1L.

**BmC—Blendon fine sandy loam, 2 to 6 percent slopes.** This is a deep, gently sloping, well drained soil on alluvial fans and terraces. The soil formed in loamy and sandy eolian material and in glacial outwash. The areas of this soil range from 5 to 175 acres in size.

Typically, the surface layer is very dark grayish brown, friable sandy loam about 11 inches thick. The subsurface layer is also very dark grayish brown, friable fine sandy loam; it is about 8 inches thick. The subsoil is friable fine sandy loam about 25 inches thick. In the upper part it is dark grayish brown, and in the lower part it is dark brown. The underlying material is brown and pale brown fine sand to a depth of more than 60 inches. In some areas the dark colors of the surface layer are dominant to a depth of 60 inches. In some areas pebbles make up

as much as 15 percent of the volume in the underlying material. In some small areas the soil is slightly higher in clay.

Included with this soil in mapping are small areas of Nimbro soils. Nimbro soils are in the lowest positions on the landscape adjacent to the waterways, are stratified, and have slightly more clay throughout. The included soils make up about 10 percent of the map unit.

Permeability is moderately rapid in the surface and subsurface layers and the subsoil and rapid in the underlying material. The available water capacity is moderate. Runoff is slow. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderately high.

About half of the acreage of this soil is dry-farmed. Some areas are under sprinkler irrigation. Some areas are used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion and soil blowing are the main hazards. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the soil surface, is needed to protect the surface. Conservation practices, such as grassed waterways, terraces, and contour farming, help to conserve moisture and to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the water-holding capacity of the soil.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. The major hazards are water erosion and soil blowing. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to control water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to conserve moisture and to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the water-holding capacity of the soil. Light, frequent applications of irrigation water help to control erosion and to reduce the leaching of plant nutrients and use the water with maximum efficiency.

This soil is suited to introduced or domesticated grasses or legumes for pasture or hayland. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity and damage the protective cover. Pasture and hayland management, such as rotation grazing, proper stocking rates, and fertilization, are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high

productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

The soil is suited to use as rangeland. This use is effective in controlling soil blowing and water erosion. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the site is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue grama, purple lovegrass, sand dropseed, and western wheatgrass increase.

The soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation can provide supplemental moisture during periods of insufficient rainfall. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation between the tree rows with conventional equipment. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil readily absorbs the effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capacity of the sandy material within 40 inches of the surface may allow effluent to pollute the ground water. This soil generally is suited to use as building sites. Crowning roads by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to the roads by frost action is reduced or prevented.

This soil is in capability units IIIe-3, dryland, and IIIe-8, irrigated; in the Sandy range site; and in windbreak suitability group 5.

**Bn—Blendon loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on terraces. The soil formed in loamy and sandy eolian material and in glacial outwash. The areas of this soil range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray, very friable loam about 7 inches thick. The subsurface layer is also very dark gray, very friable loam; it is about 3 inches thick. The subsoil is about 27 inches thick. In the upper part it is very dark gray, very friable sandy loam, in the middle part it is very dark grayish brown, very friable sandy loam, and in the lower part it is dark grayish brown, very friable loamy coarse sand. The underlying material is pale brown coarse sand to a depth of more than 60 inches. In some areas the dark colors of the surface layer are dominant to a depth of 60 inches. In some areas pebbles make up as much as 20 percent of

the volume in the underlying material. In some small areas the soil is slightly higher in clay.

Included with this soil in mapping are small areas of Nimbro soils. Nimbro soils are in slightly lower positions on the landscape adjacent to waterways, are stratified, and have slightly more clay throughout than the Blendon soil. The included soils make up about 10 percent of the map unit.

Permeability is moderately rapid in the surface and subsurface layers and subsoil and rapid in the underlying material. The available water capacity is moderate. Runoff is slow. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderately high.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated, mainly by sprinkler systems. The rest is used mainly as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the water-holding capacity of the soil.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. In some places leveling may be required for gravity systems. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the water-holding capacity of the soil.

This soil is suited to introduced or domesticated grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. If the grasses are hayed, timely mowing helps to maintain high productivity. Nitrogen and phosphate fertilizer increases the growth and vigor of the grasses.

This soil is suited to use as rangeland. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the site is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue

grama, purple lovegrass, sand dropseed, and western ragweed increase.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation can provide supplemental moisture during periods of insufficient rainfall. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation between the rows with conventional equipment. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled.

This soil readily absorbs effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capacity of the sandy material within 40 inches of the surface may allow pollution of the groundwater by the effluent. The soil generally is suited to use as sites for buildings. Crowning roads by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to the roads by frost action is reduced or prevented.

This soil is in capability units I-1, dryland, and I-8, irrigated; in the Sandy range site; and in windbreak suitability group 5.

**BoD—Boyd silty clay, 6 to 11 percent slopes.** This is a moderately deep, strongly sloping, well drained soil on uplands. The soil formed in clayey residuum of weathered shale. The areas of this soil range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay about 6 inches thick. The subsoil is very firm silty clay and is about 20 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The underlying material is light brownish gray silty clay about 12 inches thick. Light brownish gray bedded shale is at a depth of about 38 inches. The soil and the shale are calcareous throughout. In some small areas the surface layer is clay loam or silty clay loam. In some small areas the depth to shale is as much as 60 inches.

Included with this soil in mapping are small areas of Betts and Redstoe soils. Betts soils and the Boyd soil are in similar positions on the landscape. Betts soils formed in glacial till. Redstoe soils formed in silty residuum of soft, calcareous siltstone and are in lower positions on the landscape than those of the Boyd soil. Redstoe soils have less clay and more silt than the Boyd soil. The included soils make up about 10 percent of the map unit.

Permeability is very slow. The available water capacity is low. Runoff is rapid. The organic matter is moderate. Tilth is fair. The shrink-swell potential is high throughout.

About half of the acreage of this soil is dry-farmed. The rest is used as pasture or rangeland.

Under dryland management, this soil is poorly suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. The low available water capacity is the major limitation. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. Conservation practices, such as grassed waterways, terraces, and contour farming, help to conserve moisture and to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the infiltration of water.

This soil is not suited to irrigation.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hayland can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. This soil is subject to water erosion. Overgrazing or improper haying methods cause poor plant vigor, reduce productivity, and damage the protective cover. As a result, small gullies and rills are common after heavy rains. Such management practices as rotation grazing and fertilization are needed to maintain the grasses in good condition and to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, sideoats grama, green needlegrass, and western wheatgrass. If the site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, western wheatgrass, and green needlegrass increase. If overgrazing continues for many years, brushy and unpalatable plants increase; these include common pricklypear, buckbrush, Arkansas rose, western snowberry, and smooth sumac.

This soil is poorly suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival and growth rates even of adapted species are poor. The high clay content, slope, and the cracks that form as the drying soil shrinks contribute to the droughtiness of the soil. The soil should be prepared for planting when it is moist but not wet. Sites may be prepared by tillage or a combination of chemicals and tillage. Light cultivation and supplemental watering during periods of insufficient moisture close the cracks and protect the roots.

This soil is not suited to use as septic tank absorption fields. The limitations are the very slow permeability and the moderate depth to bedrock. An alternate site should



be considered. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Buildings need to be properly constructed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse-grained base material. The base material for roads can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This soil is in capability unit IVe-4, dryland, in the Clayey range site, and in windbreak suitability group 4C.

**BoE—Boyd silty clay, 11 to 15 percent slopes.** This is a moderately deep, moderately steep, well drained soil on uplands. The soil formed in clayey residuum of weathered shale. The areas of this soil range from 5 to 60 acres in size.

Typically, the surface layer is dark gray, friable silty clay about 7 inches thick. The subsoil is very firm, silty clay about 14 inches thick. In the upper part it is grayish brown, and in the lower part it is light brownish gray. The underlying material is light brownish gray silty clay. The soil is calcareous throughout. Bedded shale is at a depth of about 31 inches. In some small areas the surface layer is clay loam or silty clay loam.

Included with this soil in mapping are small areas of Betts and Redstoe soils. Betts soils and the Boyd soil are in similar positions on the landscape, but Betts soils formed in till and have more sand and silt as well as igneous pebbles that are mixed throughout the profile. Redstoe soils formed in silty residuum of soft, calcareous siltstone and are in lower positions on the landscape than the Boyd soil. They have less clay and more silt than the Boyd soil. The included soils make up 5 to 10 percent of the map unit.

Permeability is very slow. The available water capacity is low. Runoff is rapid. The organic matter content is moderate. The soil tilth is fair. The shrink-swell potential is high throughout.

Most of the acreage of this soil is used as pasture or rangeland. A small amount is dry-farmed.

This soil is not suited to farming, either dryland or irrigated.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. The most common grass is smooth brome. This soil is subject to water erosion. Overgrazing or improper haying methods cause poor plant vigor, reduce productivity, and damage the protective cover. As a result, small gullies and rills are common after heavy rains. Management practices, such as rotation grazing and fertilization, are needed to maintain the grasses in good condition and to achieve highest forage production. If the grasses are hayed, timely mowing helps to

maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, sideoats grama, green needlegrass, and western wheatgrass. If the range site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, western wheatgrass, and green needlegrass increase. If overgrazing continues for many years, brushy and unpalatable plants increase; these include common pricklypear, buckbrush, Arkansas rose, western snowberry, and smooth sumac.

This soil is poorly suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival and growth rates even of adapted species are poor. The high clay content, slope, and the cracks that form as the drying soil shrinks contribute to the droughtiness of the soil. The soil should be prepared for planting when it is moist but not wet. Planting trees on the contour helps to save moisture and to prevent excessive runoff. Light cultivation and supplemental watering during periods of insufficient moisture close the cracks and protect the roots.

This soil is not suited to use as septic tank absorption fields. The limitations are the very slow permeability and the moderate depth to bedrock. An alternate site should be considered. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Buildings need to be properly designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material. The base material can be mixed with additives, such as hydrated lime, to help prevent shrinking and swelling.

This soil is in capability unit VIe-4, dryland; in the Clayey range site; and in windbreak suitability group 4C.

**Ce—Colo silty clay loam, 0 to 2 percent slopes.**

This is a deep, nearly level, somewhat poorly drained soil on bottom lands. The soil formed in silty alluvium. It is subject to occasional flooding early in spring. The areas of this soil range from about 5 to 300 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer is very dark gray, friable silty clay loam; it is about 20 inches thick. The subsoil is dark gray, friable silty clay loam about 9 inches thick. The underlying material is dark grayish brown and grayish brown silty clay loam to a depth of more than 60 inches. The underlying material is mottled throughout. In some small areas the surface

layer is silt loam. In some small areas there are slightly calcareous subhorizons. In some places there are mottles at a depth of 26 inches.

Included with this soil in mapping are small areas of Alcester, Aowa, Baltic, Kezan, and Shell soils. Alcester soils are well drained and are on foot slopes slightly higher on the landscape than the Colo soil. Aowa and Kezan soils are calcareous and stratified and are adjacent to waterways. Aowa soils are well drained, and Kezan soils are poorly drained. Baltic soils and the Colo soil are in similar positions on the landscape, but Baltic soils have calcium carbonate within 10 inches of the surface. Shell soils are well drained and are slightly higher on the landscape than the Colo soil. The included soils make up about 15 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is slow. The organic matter content is high. Tilth is good. The shrink-swell potential is high throughout. The water intake rate is low. The seasonal high water table is at a depth ranging from about 1 foot in wet years to about 3 feet in dry years.

Most of the acreage of this soil is farmed, mainly dry-farmed. Some areas are irrigated. The rest is mainly used as pasture.

Under dryland management, this soil is suited to corn, soybeans, and alfalfa. Occasional flooding is the main hazard. Wetness caused by the high water table is the main limitation. Flooding and wetness sometimes delay tillage and timely planting. Wetness also retards warming of the soil in the spring. Terraces, diversions, and conservation tillage on nearby uplands help to control runoff and thus to reduce wetness in areas of this soil. Grassed waterways can be constructed across or around this soil to confine runoff water and to reduce the hazard of flooding. Tile drains improve internal drainage if suitable outlets are available. Ditching can improve surface drainage. Conservation tillage, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems are suited to this soil. Land leveling helps to improve surface drainage and to increase the efficiency of an irrigation system. Flooding and wetness sometimes delay tillage and timely planting. Terraces, diversions, and conservation tillage on nearby uplands help to keep excess water from flooding this soil. Grassed waterways can be constructed across or around areas of this soil to confine runoff and to reduce flooding. Tile drains improve internal drainage if suitable outlets are available. Ditching can improve drainage. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure

crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced grasses for pasture. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Proper stocking, rotation grazing, and weed control are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks. It provides a good site for adapted species that tolerate wetness, and survival and growth rates are good. Only those trees and shrubs that tolerate occasional wetness should be selected. Competition for moisture from weeds and grasses is the main hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled.

This soil is not suited to use as septic tank absorption fields. The limitations are flooding, wetness, and slow permeability. An alternate site should be considered. This soil is not suited to use as building sites. The limitations are flooding, the high shrink-swell potential, and wetness. An alternate site should be considered. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect the roads from flood damage and wetness. Roads need to be constructed so that the pavement and subbase are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse subgrade or base material. Damage to roads by frost action can be reduced by providing good surface drainage and by placing a gravel moisture barrier in the subgrade. Good surface drainage is provided by crowning the road by grading and constructing adequate side ditches.

This soil is in capability units 1lw-4, dryland, and 1lw-3, irrigated; in the Subirrigated range site; and in windbreak suitability group 2S.

#### **CfF—Crofton silt loam, 15 to 30 percent slopes.**

This is a deep, steep, somewhat excessively drained soil on uplands. The soil formed in loess. The areas of this soil range from 20 to 975 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam 6 inches thick. A transitional layer is brown, very friable silt loam 4 inches thick. The underlying material is silt loam to a depth of more than 60 inches. In the upper part it is pale brown, and in the lower part it is light yellowish brown. The soil is calcareous throughout. Small calcium carbonate





Figure 7.—Crofton silt loam, 15 to 30 percent slopes, is suited to use as rangeland. The native grasses are grazed by beef cattle.

concretions are present in the soil between depths of 6 and 18 inches. In eroded places fine or medium calcium carbonate concretions are exposed at the surface. Some areas are moderately steep or very steep.

Included with this soil in mapping are small areas of Alcester and Nora soils. Alcester soils are on relatively narrow, plane or concave foot slopes adjacent to drainageways. Nora soils are on less steep, plane or slightly concave slopes. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is rapid. The organic matter content is low.

Most of the acreage of this soil is in native grass and is used as rangeland. A few small areas are in dry-farmed crops and in introduced pasture grasses.

This soil is not suited to cultivated crops. It is too erodible for cultivation, and it is too steep to traverse safely with farm machinery.

This soil is suited to use as rangeland (fig. 7), and this use is effective in controlling water erosion. The natural

plant community consists mainly of tall and mid grasses dominated by big bluestem, switchgrass, and sideoats grama. If the site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the site; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil generally is not suited to trees and shrubs in windbreaks or to plantings for recreation use and for wildlife. Soil drainage and slope are severe limitations to planting, survival, and growth of trees and shrubs. In some places tree and shrub plantings can be made if special techniques, such as hand planting and specialized site preparation, are used.

This soil generally is not suited to use as sanitary facilities because of steep slopes. An alternate site should be considered. Buildings should be designed to

accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse-grained base material. Cutting and filling generally are needed to provide a suitable grade for roads.

This soil is in capability unit VIe-9, dryland; in the Limy Upland range site; and in windbreak suitability group 10.

**CfG—Crofton silt loam, 30 to 60 percent slopes.**

This is a deep, very steep, excessively drained soil on uplands. The soil formed in loess. Catsteps are common. The areas of this soil range from 10 to 70 acres in size.

Typically, the surface layer is dark grayish brown, calcareous, friable silt loam about 5 inches thick. A transitional layer is brown, calcareous, friable silt loam 5 inches thick. The underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches. Small calcium carbonate concretions are abundant on the surface and throughout the profile.

Included with this soil in mapping are small areas of well drained Nora soils on lower plane slopes commonly adjacent to drainageways. Also included are a few outcrops of shale and chalk on lower slopes and in drainageways. The included soils make up 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is very rapid. The organic matter content is low.

Nearly all of the acreage of this soil is in native grasses and is used as rangeland.

This soil is not suited to cultivated crops or to introduced grasses for pasture. It is too erodible, and it is too steep to traverse safely with farm machinery.

This soil is suited to use as rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, sideoats grama, and plains muhly. If the range site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, plains muhly, sand dropseed, Kentucky bluegrass, and numerous perennial broadleaf weeds and grasses increase. Also, bur oak, eastern redcedar, Woods rose, buckbrush, soapweed, snowberry, and sumac rapidly encroach on the site. Brush management and prescribed burning may be needed to control the woody plants.

This soil generally is not suited to trees and shrubs in windbreaks or to plantings for recreation use and for wildlife. Soil drainage and slope are severe limitations to planting and growth of trees and shrubs. In some places tree and shrub plantings can be made if special techniques are used, such as hand planting and specialized site preparation.

This soil generally is not suited to use as sites for sanitary facilities, buildings, or roads because of the very

steep slopes. An alternate site should be considered. If alternate sites are not available, buildings need to be designed to accommodate the very steep slope, or the soil can be graded. Cutting and filling are needed to provide a suitable grade for roads. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse-grained base material.

This soil is in capability unit VIIe-9, dryland; in the Thin Loess range site; and in windbreak suitability group 10.

**ChG—Crofton-Alcester silt loams, 20 to 60 percent slopes.**

This map unit consists of deep, steep and very steep soils on strongly dissected uplands (fig. 8). Crofton soils formed in loess, and Alcester soils formed in silty colluvium. Generally, the excessively drained Crofton soil is on the upper slopes and in convex positions on the landscape. The well drained Alcester soil is on the lower slopes and in concave positions on the landscape. Crofton soil makes up about 45 percent of the map unit, Alcester soil makes up about 35 percent, and the included soils make up 5 to 20 percent. Crofton and Alcester soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 20 to 1,150 acres in size.

Typically, the surface layer of the Crofton soil is grayish brown, friable silt loam about 5 inches thick. A transitional layer is light brownish gray, friable silt loam about 8 inches thick. The underlying material to a depth of more than 60 inches is pale brown over very pale brown silt loam. The soil is calcareous throughout.

Typically, the surface layer of the Alcester soil is very dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsoil is friable silt loam about 31 inches thick. It is grayish brown in the upper part and brown in the lower part. The underlying material is brown, calcareous silt loam to a depth of more than 60 inches. In some small areas the lower part of the subsoil is calcareous. In some small areas the slope is less than 20 percent.

Included with these soils in mapping are small isolated areas of Betts soils, siltstone outcrops, and Nora soils. Betts soils formed in clay loam glacial till and generally have rounded igneous rocks on the surface. Siltstone outcrops occur where the loess is thin over the underlying soft, consolidated siltstone. Nora soils have a surface layer that is thicker and darker than that of the Crofton soil but not so thick as that of the Alcester soil.

Permeability is moderate. The available water capacity is high. Runoff is very rapid. The organic matter content is low in the Crofton soil and high in the Alcester soil.

In most areas these soils are covered by bur oak and redcedar. They are used mainly as habitat for wildlife or as rangeland.



**Figure 8.—A typical area of Crofton-Alcester silt loams, 20 to 60 percent slopes. The Crofton soil is in the steepest and most convex positions. The Alcester soil is on the lower slopes and in the most concave positions. Bur oak and redcedar are on the lower slopes, and grasses and forbs are on the crests. These soils provide habitat for upland wildlife.**

These soils are not suited to cultivated crops. They are erosive and are too steep to traverse safely with farm machinery.

These soils are suited to use as rangeland or for habitat for wildlife. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses, shrubs, and trees dominated by big or sand bluestem, little bluestem, sideoats grama, plains muhly, needleandthread, and bur oak. If the site is overgrazed, grasses decrease in abundance and bur oak and shrubs increase. Brush management and prescribed burning may be needed to control the woody plants.

These soils generally are not suited to trees and shrubs in windbreaks or to plantings for recreation use and for wildlife. The growth rate even of adapted species

is poor. The slope severely limits planting. In some places trees and shrubs can be planted if special techniques, such as hand planting or specialized site preparation, are used.

These soils generally are not suited to use as sites for sanitary facilities or buildings because of the steep and very steep slopes. An alternate site should be considered. Extensive cutting and filling generally are needed to provide a suitable grade for roads. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.



These soils are in capability unit VIIe-1, dryland; in the Savannah range site; and in windbreak suitability group 10.

**CkG—Crofton-Gavins silt loams, 30 to 60 percent slopes.** This map unit consists of very steep, excessively drained soils on upland breaks adjacent to the Missouri River. The soils formed in loess and in residuum of soft calcareous siltstone. Generally, the deep Crofton soil is on the upper and lower slopes, and the shallow Gavins soil is on the middle slopes. The Crofton soil makes up about 60 percent of the map unit, the Gavins soil makes up about 25 percent, and the included soils make up about 15 percent. Crofton and Gavins soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 50 to 225 acres in size.

Typically, the surface layer of the Crofton soil is light brownish gray, friable silt loam about 5 inches thick. A transitional layer is also light brownish gray, friable silt loam; it is about 8 inches thick. The underlying material is pale brown silt loam to a depth of more than 60 inches. The soil is calcareous throughout.

Typically, the surface layer of the Gavins soil is grayish brown, friable silt loam about 3 inches thick. A transitional layer is light brownish gray, friable silt loam and is about 9 inches thick. The underlying material is white silt loam. Soft calcareous siltstone is at a depth of about 18 inches. The soil is calcareous throughout. In some small areas the slope is more than 60 percent or less than 30 percent.

Included with these soils in mapping are Alcester soils, small areas of soils that formed in sandy or clayey glacial till and outwash, siltstone outcrops, and Nora soils. Alcester soils are on concave slopes along hillside drainageways and on foot slopes. The sandy or clayey glacial material is discontinuously exposed. Generally, it is under the loess cap and above the siltstone or on colluvial slopes below till outcrops. Nora soils are deep, and their surface layer is thicker and darker than that of the Crofton soil.

Permeability is moderate. The available water capacity of the Crofton soil is high, and that of the Gavins soil is low. Runoff is medium. The organic matter content is low in the Crofton soil and moderate in the Gavins soil.

In most areas these soils are covered by ash, redcedar, and bur oak. They are used mainly as habitat for wildlife.

The soils are not suited to cultivated crops, pasture, or range. They are generally not suited to trees and shrubs in windbreaks. In some places trees and shrubs can be planted if special techniques are used, such as hand planting and special site preparation.

These soils generally are not suited to sanitary facilities or to use as building sites because of the very steep slope, and the shallowness of the Gavins soil. An alternate site should be considered.

Cutting and filling generally are needed to provide a suitable grade for roads. The pavement and base material should be thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material, such as sand or gravel.

These soils are in capability unit VIIe-9, dryland, and in windbreak suitability group 10. They were not assigned to a range site.

**CnC2—Crofton-Nora complex, 2 to 6 percent slopes, eroded.** This complex consists of deep, gently sloping, well drained soils in the highest positions on loess upland plains. Generally, the Crofton soil is in the steeper, more convex positions, and the Nora soil is in the more concave positions. The Crofton soil makes up about 50 percent of the complex, the Nora soil makes up about 40 percent, and the included soils make up about 10 percent. In some areas the Nora soil is dominant. The Crofton and Nora soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 10 to 50 acres in size.

Typically, the surface layer of the Crofton soil is light brownish gray, friable silt loam about 6 inches thick. A transitional layer is pale brown, friable silt loam about 7 inches thick. The underlying material is silt loam to a depth of more than 60 inches. The upper part is pale brown, and the lower part is very pale brown. The soil is calcareous throughout.

Typically, the surface layer of the Nora soil is dark grayish brown, friable silty clay loam about 5 inches thick. The subsurface layer is also dark grayish brown, friable silty clay loam. It is about 3 inches thick. The subsoil is about 25 inches thick. It is brown, friable silty clay loam in the upper part; pale brown, friable silty clay loam in the middle part; and pale brown, calcareous, friable silt loam in the lower part. The underlying material is very pale brown, calcareous silt loam to a depth of more than 60 inches. In some small areas, the depth to calcium carbonates is more than 30 inches. In other small areas, the dark surface layer is thinner than is typical.

Included with these soils in mapping are small areas of Alcester soils in the lowest positions in the mapped areas or in concave positions.

Permeability is moderate. The available water capacity is high. Runoff is medium. The content of organic matter in the Crofton soil is low, and in the Nora soil it is moderate. The rate of water intake is moderately high. The Crofton soil is mildly alkaline or moderately alkaline throughout. It is low in available phosphorus because it has excess calcium carbonate. Tilth is good.

Most of the acreage is dry-farmed. Some is under sprinkler irrigation. A small acreage is in native or introduced grasses.

Under dryland management, these soils are suited to corn, soybeans, oats, and alfalfa. Water erosion is the major hazard. After heavy rains, rills and small gullies are common in fields of row crops. Fertility is low because tillage has mixed the upper part of the subsoil with the remaining surface layer. Low fertility and water conservation are the main concerns in management. In the Crofton soil, excess calcium carbonate combines with phosphorus to produce insoluble calcium phosphate, which is not used by plants. Annual applications of phosphate fertilizer are needed. Terraces, contour farming, and grassed waterways help to control erosion and to conserve moisture. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to control water erosion and to conserve soil moisture. Leaving crop residue on the surface, growing green manure crops, and applying feedlot manure on the soil help to maintain or to improve the organic matter content, fertility, and tilth and also to increase the infiltration of water.

Under irrigation, these soils are suited to corn, soybeans, oats, and alfalfa. A sprinkler irrigation system works best on these soils. Water erosion is the main hazard. Adjusting the rate of water application to the intake rate of the soils helps to prevent excess runoff and to control erosion. Terraces, contour farming, and grassed waterways also help to control erosion. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to control erosion. Leaving crop residue on the surface and applying feedlot manure and commercial fertilizers, especially phosphorus and nitrogen fertilizers, in amounts determined by soil tests, help to improve fertility.

These soils are suited to introduced grasses for pasture. The most common grass is smooth brome. Rotation grazing, proper stocking rates, and nitrogen fertilizer help to keep the grasses in good condition.

These soils are suited to use as rangeland and native hayland. These uses are effective in controlling water erosion. The natural plant community is mainly tall and mid grasses dominated by big bluestem, little bluestem, indiangrass, sideoats grama, switchgrass, and western wheatgrass. If an area is overgrazed or is hayed at an improper time, the site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. In addition, woody plants may migrate to or invade the site; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

These soils are suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Planting trees on the contour in combination with terraces or planting a cover crop

between the rows of trees helps to control erosion. Cultivation, careful use of selected herbicides, or hand hoeing help to control weeds. Newly planted trees may need watering if rainfall is insufficient. Trees and shrubs that tolerate excess calcium carbonates should be selected for the Crofton soil.

The soils generally are suited to use as septic tank absorption fields. The Crofton soil generally is suited to use as sites for buildings. On the Nora soil, foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil.

There are severe limitations to use of the soils for roads. The pavement and subbase should be thick enough to compensate for the low soil strength. Also, the upper part of the soils can be covered or replaced with a coarse subgrade or base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

These soils are in capability units IIIe-9, dryland, and IIIe-6, irrigated. The Crofton soil is in the Limy Upland range site and in windbreak suitability group 8. The Nora soil is in the Silty range site and in windbreak suitability group 3.

**CnD2—Crofton-Nora complex, 6 to 11 percent slopes, eroded.** This complex consists of deep, strongly sloping, well drained soils on plane or convex hillsides on uplands (fig. 9). The soils formed in loess. Generally, the Crofton soil is on the upper parts of hillsides and in convex areas, and the Nora soil is on the lower plane hillsides. The Crofton soil makes up about 60 percent of the map unit, the Nora soil makes up about 30 percent, and the included soils make up 10 percent. In some areas the Nora soil is dominant. The Crofton and Nora soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 5 to 650 acres in size.

Typically, the surface layer of the Crofton soil is grayish brown, friable silt loam about 5 inches thick. A transitional layer is pale brown, friable silt loam about 7 inches thick. The underlying material is silt loam to a depth of more than 60 inches. In the upper part it is pale brown, and in the lower part it is very pale brown. The soil is calcareous throughout.

Typically, the surface layer of the Nora soil is dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is brown, friable silt loam about 14 inches thick. The underlying material is brown and pale brown, calcareous silt loam to a depth of more than 60 inches. In some areas the depth to calcium carbonates is more than 30 inches. In some small areas the dark surface layer is thinner.

Included with these soils in mapping are small areas of Alcester soils on foot slopes in the lowest positions on



Figure 9.—A typical area of Crofton-Nora complex, 6 to 11 percent slopes, eroded. The light-colored areas at center are Crofton soil, which has a low content of organic matter, and the darker areas are Nora soil. Corn is the crop on the foreground slope and in fields in the distance.

the landscape. The included soils make up about 10 percent of the map unit.

Permeability is moderate, and the available water capacity is high. Runoff is medium. The organic matter content is low in the Crofton soil and is moderate in the Nora soil. The water intake rate is moderate. The Crofton soil is mildly alkaline or moderately alkaline throughout the profile. It is low in available phosphorus because of excess calcium carbonate. Tilth is good.

Most of the acreage of these soils is cultivated. Dryfarming is dominant, but irrigation is increasing. A small acreage is in native or introduced grasses.

Under dryland management, the soils are poorly suited to cultivated crops. Corn, soybeans, oats, and alfalfa are the main crops. Water erosion is the major hazard. Erosion has removed much of the original surface layer. Fertility is low because tillage has mixed the upper part of the subsoil with the remaining surface layer. Low fertility and water conservation are the main concerns in management. In the Crofton soil, excess calcium carbonate combines with phosphorus to form insoluble calcium phosphate, which is not used by plants. Annual applications of phosphate fertilizer are needed. Terraces,

contour farming, and grassed waterways help to prevent erosion and to conserve moisture. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, the soils are poorly suited to corn or soybeans but are suited to close-grown crops, such as oats and alfalfa. A sprinkler irrigation system works best on these soils. Gravity systems are not suited. Water erosion is the main hazard. Low fertility is a major concern in management. Adjusting the application rate of water to the water intake rate helps prevent excess runoff and to control erosion. Terraces, contour farming, and grassed waterways help to control erosion. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to control erosion. Returning crop residue to the soil and applying feedlot manure and phosphate and nitrogen fertilizers, in

amounts determined by soil tests, help to improve fertility.

The soils are suited to introduced grasses for pasture. The most common grass is smooth brome. Rotation grazing, proper stocking rates, and nitrogen fertilizer help keep the grasses in good condition.

The soils are suited to rangeland and to native hayland. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, indiangrass, sideoats grama, switchgrass, and western wheatgrass. If the site is overgrazed or is hayed at an improper time, the range site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the site; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

The soils are suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Erosion can be controlled by planting trees on the contour in combination with terraces or by planting a cover crop between the rows of trees. Weeds can be controlled by cultivation, careful use of selected herbicides, or hand hoeing. Newly planted trees may need watering if rainfall is insufficient. Trees and shrubs that tolerate excess calcium carbonate should be selected for the Crofton soil.

Land shaping and installing septic tank absorption fields on the contour generally are necessary for proper operation. Buildings need to be properly designed to accommodate the slope, or the soil can be graded. On the Nora soil, foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse subgrade or base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

These soils are in capability units IVe-9, dryland, and IVe-6, irrigated. The Crofton soil is in the Limy Upland range site and in windbreak suitability group 8. The Nora soil is in the Silty range site and in windbreak suitability group 3.

**CnE2—Crofton-Nora complex, 11 to 15 percent slopes, eroded.** This complex consists of deep, moderately steep, well drained soils on ridges and side slopes on uplands. These soils formed in loess. The Crofton soil is on the narrow ridgetops and upper side slopes. The Nora soil is on the lower side slopes. The

Crofton soil makes up about 60 percent of the complex, the Nora soil makes up about 30 percent, and the included soils make up 10 percent. The Crofton and Nora soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 5 to 175 acres in size.

Typically, the surface layer of the Crofton soil is grayish brown, friable silt loam about 6 inches thick. A transitional layer is brown, friable silt loam about 6 inches thick. The underlying material is pale brown silt loam to a depth of more than 60 inches. This soil is calcareous throughout. Small calcium carbonate concretions are on the surface and throughout the profile.

Typically, the surface layer of the Nora soil is dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil is brown, friable silty clay loam about 10 inches thick. Calcium carbonates are at a depth of 11 inches. The underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches. In some small areas the surface layer is 7 to 12 inches thick. In a few small areas the depth to calcium carbonates is more than 30 inches. In other small areas the surface layer is silt loam.

Included with this unit in mapping are small areas of Alcester and Hobbs soils. Alcester soils are on foot slopes and are around the head of upland drainageways. Hobbs soils are on bottom lands in the lowest positions on the landscape. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is medium. The organic matter content is low in the Crofton soil and is moderate in the Nora soil. The Crofton and Nora soils are low in available phosphorus because they have excess calcium carbonate. Tilth is good.

About half of the acreage of these soils is cultivated. The rest is in native or introduced grasses.

Under dryland management, these soils are poorly suited to cultivated crops. Corn, oats, and alfalfa are the main crops. The soils are best suited to close-growing crops that effectively control water erosion. After heavy rains, small gullies and rills are common in fields of row crops. Fertility is low because tillage has mixed the upper part of the subsoil with the remaining surface layer. Low fertility and water conservation are the main concerns in management. In the Crofton soil, the excess calcium carbonate combines with phosphorus to form insoluble calcium phosphate, which is not used by plants. Annual applications of phosphate fertilizer are needed. Terraces, contour farming, and grassed waterways help to prevent erosion and to conserve moisture. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the

soil help to maintain and to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

The soils generally are not suited to irrigation because of the moderately steep slopes and the high risk of water erosion.

The soils are suited to introduced grasses for pasture. The most common grass is smooth brome. Rotation grazing, proper stocking rates, and nitrogen fertilizer help to keep the grasses in good condition.

These soils are suited to use as rangeland. This use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the soils; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

These soils are suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, survive and grow well. Erosion can be controlled by planting trees on the contour in combination with terraces or by planting a cover crop between the rows of trees. Plant competition can be controlled by cultivation, careful use of selected herbicides, or hand hoeing. Newly planted trees may need watering during periods of insufficient rainfall.

Land shaping and installing the distribution lines on the contour generally are necessary for proper operation of a septic tank absorption field. Buildings need to be properly designed to accommodate the slope, or the soils can be graded. On the Nora soil, foundations for buildings need to be strengthened and backfilled with coarse material; thus, damage caused by the shrinking and swelling of the soil is prevented. Roads need to be constructed so that the surface pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse subgrade or base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads caused by frost action is reduced or prevented.

These soils are in capability unit IVe-9, dryland. The Crofton soil is in the Limy Upland range site and in windbreak suitability group 8. The Nora soil is in the Silty range site and in windbreak suitability group 3.

**Dm—Dudley-Moody complex, 0 to 2 percent slopes.** This complex consists of deep, nearly level soils on uplands. The soils formed in loess. The Dudley soil is moderately well drained, and the Moody soil is well

drained. The Dudley soil makes up about 70 percent of the complex, the Moody soil makes up about 20 percent, and the included soils make up 10 percent. The Dudley soil consists of a series of "slick spots" that are sparsely vegetated because of the high content of alkali. The Dudley and Moody soils are in areas that are so intricately mixed or so small in size that it was not practical to map the soils separately. The mapped areas range from 10 to 215 acres in size.

Typically, the surface layer of the Dudley soil is grayish brown, firm silt loam about 4 inches thick. The subsurface layer is dark gray, very firm silt loam about 3 inches thick. The subsoil is silty clay loam about 19 inches thick. It is very firm and very dark grayish brown in the upper part, very firm and grayish brown in the middle part, and firm and brown in the lower part. The underlying material is pale brown and is silty clay loam in the upper part over silt loam in the lower part. It extends to a depth of more than 60 inches. In some areas the subsoil does not have gypsum crystals. In some places the depth to calcium carbonates is as much as 44 inches, or the dark colors of the surface layer extend to a depth of about 26 inches, or both of these characteristics are present.

Typically, the surface layer of the Moody soil is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 44 inches thick. It is very dark grayish brown in the upper part, dark brown over brown in the middle part, and light brownish gray in the lower part. The underlying material is pale brown silty clay loam to a depth of more than 60 inches. In some areas the dark colors of the surface layer extend to a depth of more than 20 inches. In some areas the soils are moderately well drained or the subsoil is more strongly developed (that is, it is higher in clay content) or both.

Included with these soils in mapping are small areas of Fillmore soils. Fillmore soils are poorly drained and are in the lowest depressional positions. The included soils make up about 10 percent of the map unit.

Permeability is slow in the Dudley soil and moderately slow in the Moody soil. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is poor in the Dudley soil and good in the Moody soil. The Dudley soil has a moderate alkali content in the solum.

Most of the acreage of these soils is used as pasture. The rest is farmed. About half of the farmed areas have sprinkler irrigation systems.

Under dryland management, these soils are poorly suited to corn, soybeans, alfalfa, and oats. The Dudley soil is not suited to crops because of alkalinity. There are no suitable or economic management practices that can overcome this limitation. The Dudley soil can support only thin stands of poor crops. The Moody soil is suited to crops. Because of the intricate pattern and dominance of the Dudley soil in this complex, the Moody soil cannot



be managed very satisfactorily. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. The best management practices are using a cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, these soils are not suited to crops.

These soils are suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome, but tall wheatgrass and switchgrass are suited. Overgrazing or grazing when the soils are wet causes compaction and poor soil tilth. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. If the grasses are hayed, timely mowing helps to maintain high productivity.

The soils are poorly suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The Dudley soil is poorly suited because of the alkali content. This limitation can be minimized by using only adapted alkali-tolerant species, but survival and growth rates are poor. The Moody soil is suited to trees and shrubs. The survival and growth rates for adapted species are good. Competition for moisture from weeds and grasses is the major hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

Slow permeability is a severe limitation to use of the Dudley soil as a septic tank absorption field. An alternate site should be considered. Moderately slow permeability is a severe limitation to use of the Moody soil as septic tank absorption fields, but this limitation generally can be overcome by increasing the size of the absorption field. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soils.

There are severe limitations to use of the soils for roads. The pavement and base material should be thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

These soils are in capability unit IVs-1, dryland. The Dudley soil is in the Clayey range site, and the Moody soil is in the Silty range site. The Dudley soil is in windbreak suitability group 9N, and the Moody soil is in windbreak suitability group 3.

**EI—Eltree silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on foot slopes and

on nearly level or slightly depressional uplands. The soil formed in loess. The areas of this soil range from 5 to 115 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is also dark grayish brown, friable silt loam; it is about 10 inches thick. The subsoil in the upper part is dark grayish brown, friable silt loam about 9 inches thick. In the middle part it is brown, friable silty clay loam about 8 inches thick. In the lower part it is pale brown, friable silty clay loam about 13 inches thick. The subsoil has accumulations of calcium carbonates throughout. The underlying material is light gray silt loam to a depth of more than 60 inches. It also has accumulations of calcium carbonates. In some small areas the soil is noncalcareous to a depth of 15 inches or more. In some small areas the dark color of the surface layer is dominant to a depth of more than 40 inches.

Included with this soil in mapping are small areas of Alcester soils and the bedrock substratum phase of Hord soils. These soils and the Eltree soil are in similar positions on the landscape. Alcester soils are gently sloping and have calcium carbonates at a depth of more than 36 inches. The Hord soil has soft calcareous siltstone within a depth of about 45 to 60 inches and commonly has thicker dark colored layers. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated, and some are used as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. Less site preparation is needed if a sprinkler system is used. In some places leveling may be required for gravity systems to achieve the proper grade. Timely application and uniform distribution of water are needed for efficient water use. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced grasses for pasture. The most common grass is smooth brome. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. Nitrogen fertilizer increases the growth and vigor of the grasses. Irrigation water can be applied by sprinkler or gravity systems. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks. It is also suited to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are good. Competition for moisture from weeds and grasses is the major hazard. Plant competition can be eliminated by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be eliminated by hand hoeing, rototilling, and application of appropriate herbicides.

The soil generally is suited to use as septic tank absorption fields and as sites for buildings. Roads need to be designed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units I-1, dryland, and I-6, irrigated; in the Limy Upland range site; and in windbreak suitability group 3.

**EIC—Eltree silt loam, 2 to 6 percent slopes.** This is a deep, gently sloping, well drained soil on uplands. The soil formed in loess. The areas of this soil range from 5 to 300 acres.

Typically, the surface layer is grayish brown, friable silt loam about 8 inches thick. The subsurface layer is also grayish brown, friable silt loam; it is about 18 inches thick. The subsoil is light brownish gray, friable silt loam about 32 inches thick. The underlying material is light gray silt loam to a depth of more than 60 inches. The soil is calcareous throughout. In some small areas there is soft calcareous siltstone at a depth of 35 inches. In some small areas the dark color of the surface layer is dominant to a depth of slightly less than 20 inches, or it extends to more than 40 inches. In some small areas there are no calcium carbonates within a depth of 20 inches.

Included with this soil in mapping are small areas of Nora and Redstoe soils. They and the Eltree soil are in similar positions on the landscape, but Redstoe soils are also in more convex positions. Nora soils have a dark surface layer less than 10 inches thick and generally are deeper than 15 inches to calcium carbonates. Redstoe soils are moderately deep to soft calcareous siltstone and have a dark surface layer less than 12 inches thick.

The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is medium. The organic matter content is moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. Some is irrigated. The rest is used mainly as pasture or rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Conservation tillage, such as no-till planting, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. Water erosion is the main hazard. Conservation tillage, such as no-till, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the infiltration of water. Careful application of water is needed to prevent excessive runoff, which can cause loss of soil productivity and crop damage. Adjusting the application rate of water to the intake rate of the soil helps to control runoff and erosion.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture can be alternated with crops as part of a crop rotation. The most common grass is brome. Overgrazing causes low plant vigor. As a result, small gullies and rills can form after heavy rains. Proper stocking rates and rotation grazing help to maintain the grasses in good condition. If the grasses are hayed, timely mowing helps to maintain high productivity. Nitrogen and phosphate fertilizers increase the growth and vigor of the grasses.

This soil is suited to use as rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the soil is overgrazed, the big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade

the site; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks. Survival of adapted species is good, and growth is fair. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation during periods of low rainfall improves the survival rate. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

This soil generally is suited to use as septic tank absorption fields. It generally is suited to use as building sites. However, on the steeper slopes, larger structures need to be properly designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be replaced or covered with coarse base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IIe-1, dryland, and IIle-6, irrigated; in the Limy Upland range site; and in windbreak suitability group 3.

**EID—Eltree silt loam, 6 to 11 percent slopes.** This is a deep, strongly sloping, well drained soil on uplands. The soil formed in loess. The areas of this soil range from 5 to 50 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is friable silt loam about 14 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The subsoil is friable silt loam about 23 inches thick. It is light brownish gray in the upper part and grayish brown in the lower part. The underlying material is light yellowish brown silt loam to a depth of more than 60 inches. The soil is calcareous throughout. In some small areas there is soft calcareous siltstone at a depth ranging from 30 to 60 inches. In some small areas the dark color of the surface layer extends to a depth of slightly less than 20 inches or to more than 40 inches. In some small areas the depth to calcium carbonates is as much as 20 inches.

Included with this soil in mapping are small areas of Nora and Redstoe soils. These soils and the Eltree soil are in similar positions on the landscape; however, Redstoe soils are also on more convex slopes. Nora soils have a dark surface layer less than 20 inches thick and generally have calcium carbonates at a depth of more than 15 inches. Redstoe soils are moderately deep to soft calcareous siltstone and have a dark surface

layer less than 12 inches thick. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is rapid. The organic matter content is moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. A small acreage is irrigated. The rest is used mainly as pasture or rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Conservation tillage, such as no-till planting, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. Water erosion is the main hazard. Conservation tillage, such as no-till, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to control water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion, to maintain or improve the organic matter content, fertility, and tilth, and to increase the infiltration of water. Light, frequent applications of irrigation water are needed to reduce the plant nutrients and to control excessive runoff and erosion.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture can be alternated with crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity and damage the protective cover. As a result, small gullies and rills are common after heavy rains. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to use as rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the range site is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the site; these include bur oak, eastern redcedar,

buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks. The survival rate is good and the growth rate is fair for adapted species. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation during periods of low rainfall improves the survival rate of new plantings. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

Slope is a moderate limitation to use of this soil as septic tank absorption fields. Land shaping and installing the septic tank absorption field on the contour are necessary for proper operation. Buildings need to be designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be replaced or covered with a coarse base material. Cutting and filling generally are needed to provide a suitable grade for roads and streets. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IIIe-1, dryland, and IVe-6, irrigated; in the Limy Upland range site; and in windbreak suitability group 3.

**Fm—Fillmore silt loam, 0 to 1 percent slopes.** This is a deep, nearly level, poorly drained soil in shallow, smooth depressions on uplands. It is subject to ponding of brief duration in wet seasons and after heavy rains. It commonly receives runoff from adjacent soils. The areas of this soil are roughly oblong or rounded in shape and range from 3 to 65 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer is silt loam about 16 inches thick. In the upper part it is friable and dark gray, and in the lower part it is very friable and gray. The subsoil is firm silty clay about 35 inches thick. In the upper part it is dark gray, and in the lower part it is grayish brown. The underlying material is light brownish gray, mottled silty clay to a depth of more than 60 inches. In some areas the surface layer is silty clay loam. In places there is no gray subsurface layer.

Included with this soil in mapping are small areas of Moody soils in the highest positions in the mapped areas. Moody soils are well drained, have less clay in the subsoil, and are not subject to ponding. The included soils make up about 5 percent of the map unit.

Permeability is very slow. The available water capacity is high. Runoff is very slow. The organic matter content is moderate. Tilth generally is good, but tillage operations

are often delayed because of wet conditions. The shrink-swell potential in this soil is moderate above the clayey subsoil, but it is high in the subsoil and the underlying material. The water intake rate is low. The seasonal high water table ranges from about 6 inches above the surface in wet years to about 1 foot below the surface in dry years. The soil commonly is ponded for short periods in wet seasons and after heavy rains.

Most of the acreage of this soil is dry-farmed. The rest is used mainly as pasture.

Under dryland management, this soil is suited to corn, soybeans, and oats. It is usually too wet for alfalfa unless drainage is provided. The main limitations are excessive wetness and surface ponding during wet seasons and after heavy rains. Removal of excess water is critical for consistent crop production. Excess water and ponding commonly delay planting, particularly of oats, and sometimes crops are drowned out after heavy summer rains. Excessive wetness hinders timely cultivation and effective weed control. Excessive wetness can be overcome by land leveling and surface ditching if outlets are available. Terraces, grassed waterways, and contour farming on higher lying soils help to prevent runoff from collecting on this soil. Lime commonly is needed for maximum production. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn and soybeans. A sprinkler irrigation system works best on this soil. Ponding and excessive wetness commonly delay tillage and can damage crops. These limitations can be overcome by land leveling and surface ditching. Terraces, grassed waterways, and diversions on surrounding higher lying soils help to prevent runoff from collecting on this soil.

This soil is suited to introduced grasses for pasture. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity and damage the protective cover. Proper stocking rates, rotation grazing, and weed control are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks. This soil provides a fair site. Survival and growth of trees and shrubs that tolerate wetness are good. Only those species that tolerate occasional wetness should be selected. Competition for moisture from weeds and grasses is the main hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can be

controlled by careful use of appropriate herbicides. The areas in the rows or near small trees can be hoed by hand or rototilled.

This soil is not suited to use as septic tank absorption fields. The limitations are the very slow permeability and ponding. An alternate site should be considered. The soil is not suited to use as building sites. The limitations are ponding and the shrink-swell potential. An alternate site should be considered. Constructing roads on suitable, well compacted fill material above the ponding level and constructing adequate side ditches and culverts help to protect roads from damage by ponded water. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage and by placing a gravel moisture barrier in the subgrade. Good surface drainage is provided by crowning the road by grading and by constructing adequate side ditches.

This soil is in capability unit IIIw-2, dryland and irrigated; in the Clayey Overflow range site; and in windbreak suitability group 2W.

**GaE—Gavins silt loam, 6 to 15 percent slopes.** This is a shallow, strongly sloping and moderately steep, well drained soil on uplands. The soil formed in calcareous residuum of soft siltstone. The areas of this soil range from 5 to 110 acres in size.

Typically, the surface layer is grayish brown, very friable silt loam about 6 inches thick. A transitional layer is pale brown, very friable silty clay loam about 3 inches thick. The underlying material is very pale brown silty clay loam. Soft calcareous siltstone is at a depth of about 14 inches. The soil is calcareous throughout. In some small areas the surface or transitional layer or both are loam, sandy loam, or clay loam. In some small areas there is a thick, dark surface layer. In other small areas siltstone is at a depth of slightly less than 10 inches, and in some places stones and boulders are scattered on the surface.

Included with this soil in mapping are small areas of Redstoe soils and small areas of siltstone outcrops. Redstoe soils generally are in strongly sloping areas in the lowest positions in a mapped area. They are moderately deep and have thick, dark surface and subsurface layers. The included soils make up about 10 percent of the map unit.

Permeability is moderate above the soft calcareous siltstone. The available water capacity is low. Runoff is rapid. Tilth is fair. The organic matter content is moderate.

Most of the acreage of this soil is used as pasture and rangeland, but some is dry-farmed where the soil is associated with deeper soils. This soil is not suited to farming, either dryland or irrigated.

This soil is poorly suited to introduced grasses for pasture. However, this use is effective in controlling water erosion. The most common grass is smooth brome. Overgrazing or improper haying methods cause poor plant vigor, reduce productivity, and damage the protective cover. As a result, small gullies and rills are common after heavy rains. Such management practices as rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big or sand bluestem, little bluestem, sideoats grama, prairie sandreed, plains muhly, and blue grama. If the range is overgrazed, big or sand bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, prairie sandreed, and plains muhly increase. If overgrazing continues for many years, the less desirable woody plants increase; these include bur oak, smooth sumac, buckbrush, and snowberry. Brush management and prescribed burning may be needed to control the woody plants.

This soil is not suited to trees and shrubs in windbreaks. In some places trees and shrubs can be planted if specialized site preparation, irrigation, or other specialized treatments are used.

This soil generally is not suited to use as septic tank absorption fields because it is shallow over bedrock. An alternate site should be considered. The soft bedrock generally can be easily excavated for construction of dwellings with basements or buildings that have deep foundations. Buildings should be designed to accommodate the slope, or the soil and soft bedrock can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability unit VIIs-4, dryland; in the Shallow Limy range site; and in windbreak suitability group 10.

**GaF—Gavins silt loam, 15 to 30 percent slopes.**

This is a shallow, steep, somewhat excessively drained soil on uplands. The soil formed in calcareous residuum weathered from soft siltstone. The areas of this soil range from 5 to 55 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 5 inches thick. A transitional layer is grayish brown, friable silt loam about 5 inches thick. The underlying material is very pale brown silt loam. Soft, calcareous siltstone is at a depth of about 18 inches. The soil is calcareous throughout. In some small areas siltstone is at a depth of less than 10 inches.

Included with this soil in mapping are some small areas where stones and boulders are scattered on the surface or there are coarser textures above the siltstone. Also included are a few areas of Crofton and Redstoe soils. These soils and the Gavins soil are in similar positions on the landscape. Crofton soils are deep and formed in areas of loess deposits. Redstoe soils are moderately deep and formed on the more uniform plane slopes. The included soils make up about 10 percent of the map unit.

Permeability is moderate above the soft, calcareous siltstone. The available water capacity is very low or low. Runoff is rapid. The organic matter content is moderate. Tilth is fair.

Almost all of the acreage of this soil is rangeland. The soil is not suited to cultivated crops, either dryland or irrigated, or to pasture.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big or sand bluestem, little bluestem, sideoats grama, prairie sandreed, plains muhly, and blue grama. If the range site is overgrazed, big or sand bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, prairie sandreed, and plains muhly increase. If overgrazing continues for many years, the less desirable woody plants increase; these include bur oak, smooth sumac, buckbrush, and snowberry. Brush management and prescribed burning may be needed to control the woody plants.

This soil is not suited to trees and shrubs in windbreaks. However, in some places trees and shrubs can be planted if special techniques, such as specialized site preparation, irrigation, or other specialized treatments, are used.

This soil generally is not suited to sanitary facilities because of its shallowness to bedrock and slope. An alternate site should be considered. The soft bedrock generally can be easily excavated for construction of buildings with basements or buildings that have deep foundations. Buildings should be properly designed to accommodate the slope, or the soil and soft bedrock can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse material. Cutting and filling generally are needed to provide a suitable grade for roads.

This soil is in capability unit VIIs-3, dryland, in the Shallow Limy range site, and in windbreak suitability group 10.

**Gr—Grable silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on bottom lands. The soil formed in silty over sandy sediment. It is subject to rare flooding. The areas of this soil range from 10 to 275 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. The underlying material is grayish brown silt loam to a depth of 26 inches. Below that, it is faintly mottled, light gray fine sand, to a depth of about 36 inches, over faintly mottled, light gray sand that extends to a depth of 60 inches or more. The soil is calcareous throughout. In some small areas the surface layer is very fine sandy loam or silty clay loam. In some places the colors in the upper part of the profile are lighter. In some places the silty layer is less than 18 inches or more than 30 inches thick.

Included with this soil in mapping are small areas of Blake and Sarpy soils. Blake soils are in the lowest positions on the landscape, have more silt and clay throughout the profile, and are somewhat poorly drained. Sarpy soils are in the highest positions on the landscape and have more sand in the upper part of the profile. The included soils make up about 15 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. The organic matter content is moderately low. Runoff is slow. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. Some is irrigated.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. The main limitation is insufficient moisture for crops in summer. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and fertility and to increase the water-holding capacity of the soil.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and fertility and to increase the water-holding capacity.

This soil is suited to trees and shrubs in windbreaks. The survival and growth rates of adapted species are good. Competition from weeds and grasses for moisture is the major hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil readily absorbs the effluent from septic tank absorption fields but does not adequately filter it. The poor filtering capacity may result in pollution of the ground water. Buildings constructed on elevated, well compacted fill material are protected against flooding. Constructing roads on suitable, well compacted fill



material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units IIs-5, dryland, and I-6, irrigated; in the Silty Lowland range site; and in windbreak suitability group 1.

**Hn—Hobbs silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on bottom lands. It is subject to occasional flooding, usually of brief duration, late in winter and early in spring. The soil formed in stratified silty alluvium. The areas of this soil range from 10 to 225 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The underlying material is stratified silt loam about 33 inches thick. It is dark grayish brown in the upper part, brown in the middle part, and grayish brown in the lower part. The layer below that, to a depth of more than 60 inches, is a buried soil that is very dark grayish brown, friable silt loam. In some areas the surface layer has been recently deposited; it is calcareous and is more than 10 inches thick. In some areas there are thin layers of sandy texture in some parts of the profile. In some areas this soil is not stratified in the upper 10 inches.

Included with this soil in mapping are small areas of Alcester and Colo soils. Alcester soils are not stratified and are on foot slopes above the Hobbs soil. Colo soils are somewhat poorly drained and are lower than the Hobbs soil on the landscape. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed, and some is irrigated. The rest is used mainly as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Flooding is the main hazard. Terraces, diversions, and conservation tillage on adjacent upland soils help to retain precipitation and to reduce runoff. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. In some places leveling may be required for gravity systems. Flooding is the main hazard, but damage to crops is seldom severe. Controlling runoff from adjoining uplands by use of diversion terraces reduces flooding. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green

manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced grasses for pasture. The most common grass is smooth brome. Overgrazing or improper haying methods reduce plant vigor and productivity and damage the protective cover. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks. The survival and growth rates of adapted species are good. Competition for moisture from weeds and grasses is the major hazard. Plant competition can be controlled by good site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil is not suited to use as septic tank absorption fields or building sites because of flooding. An alternate site should be considered. Roads need to be constructed so that the surface and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse material. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units IIw-3, dryland, and IIw-6, irrigated; in the Silty Overflow range site; and in woodland suitability group 1.

**Hr—Hord silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on terraces. The soil is subject to rare flooding. It formed in old silty alluvium and loess. The areas of the soil range from 10 to 525 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil, to a depth of about 45 inches, is firm silty clay loam. It is dark brown in the upper part and brown in the lower part. The underlying material is calcareous, pale brown silt loam to a depth of more than 60 inches. In some small areas the dark colors in the upper part of the profile extend to a depth of less than 20 inches. In some areas the dark colors of the surface layer extend to a depth of more than 40 inches and calcium carbonates are at a depth of more than 48 inches. In some areas there are relict mottles in the underlying material above a depth of 60 inches. In some small areas the texture is loamy in parts of the profile or throughout.

Included with this soil in mapping are small elongated areas of Aowa and Hobbs soils in the lowest positions along waterways that intersect the Hord soil. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. Tilth is good. The organic matter content is moderate. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. Some areas are irrigated. The rest is used as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems are suited to this soil. In some places leveling may be required for gravity systems. Conservation tillage, such as chiseling or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced or domesticated grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Irrigation water can be applied by sprinkler or gravity systems.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival and growth rates of adapted species are good. Competition for moisture from weeds and grasses is the major hazard. Plant competition can be controlled by good site preparation prior to planting through tillage or chemical methods and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

The hazard of rare flooding needs to be considered if this soil is used as septic tank absorption fields and building sites. Buildings can be constructed on elevated, well compacted fill material for protection against flooding. Roads need to be designed so that the pavement and base material are thick enough to

compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units I-1, dryland, and I-6, irrigated; in the Silty Lowland range site; and in windbreak suitability group 1.

**Hs—Hord silt loam, bedrock substratum, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on uplands and terraces. The soil formed in alluvium and loess. The areas of the soil range from 5 to 230 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is very dark brown, very friable silt loam about 9 inches thick. The subsoil is about 26 inches thick. In the upper part it is very dark grayish brown, very friable silty clay loam, and in the lower part it is dark grayish brown, friable silty clay loam. The underlying material is yellowish brown silty clay loam. Calcareous siltstone is at a depth of about 51 inches. The soil is calcareous below a depth of about 28 inches. In some small areas the surface layer is silty clay loam. In some areas siltstone is below a depth of 60 inches.

Included with this soil in mapping are small areas of Alcester, Lamo, and Redstoe soils. Alcester soils are in the highest positions on the landscape and have bedrock below a depth of 60 inches. Lamo soils are in the lowest positions, are somewhat poorly drained and poorly drained, and are subject to occasional flooding. Redstoe soils are in the most convex areas, are moderately deep to soft, calcareous siltstone, and are dark colored to a depth of less than 20 inches. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. Some is irrigated, and some is used as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. In some places leveling may be required for gravity systems. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. Returning crop residue to the



soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing or improper haying methods reduce productivity, damage the protective cover, and cause poor plant vigor. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are good. Competition for moisture from weeds and grasses is the major hazard. Plant competition can be eliminated by good site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and appropriate herbicides.

Septic tank absorption field sites can be raised or mounded with suitable fill material to increase the filtering capacity of the soil. The moderate permeability is a limitation for septic tank absorption fields. This limitation generally can be overcome by increasing the size of the absorption field. The soil generally is suited to use as building sites. Roads need to be constructed so that the surface and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units I-1, dryland, and I-6, irrigated; in the Silty range site; and in windbreak suitability group 3.

**In—Inavale coarse sand, channeled.** This is a deep, nearly level and very gently sloping, excessively drained soil on bottom lands. The soil is subject to frequent flooding. It formed in sandy alluvium. The areas of this soil range from 5 to 540 acres in size.

Typically, the surface layer is grayish brown, loose coarse sand about 8 inches thick. A transitional layer is light brownish gray, loose coarse sand about 12 inches thick. The underlying material is grayish brown coarse sand to a depth of more than 60 inches. In some small areas, the surface layer and lenses throughout the profile range from sandy to loamy.

Included with this soil in mapping are small areas of Hobbs and Nimbro soils. These soils and the Inavale soil are in similar positions on the landscape. Hobbs soils are silty to a depth of 60 inches or more. Nimbro soils are

silty or loamy to a depth of 60 inches or more. The included soils make up about 15 percent of the map unit.

Permeability is rapid. The available water capacity is very low. Runoff is slow. The organic matter content is low. Tilth is good.

Most of the acreage of this soil is used as rangeland. This soil is not suited to farming.

This soil is suited to use as rangeland, and this use is effective in controlling soil blowing. The natural plant community consists mainly of mid and tall grasses dominated by little bluestem, sand bluestem, prairie sandreed, switchgrass, and needleandthread. If the range site is overgrazed, the site may be dominated by blue grama, hairy grama, sand dropseed, prairie sandreed, Scribner panicum, and numerous annual and perennial weeds.

This soil is not suited to trees and shrubs in windbreaks. Survival and growth rates are poor.

This soil is not suited to use as septic tank absorption fields and as building sites because of flooding. An alternate site should be considered. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability unit Vlw-7, dryland, in the Sandy Lowland range site, and in windbreak suitability group 10.

**Ke—Kezan silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, poorly drained soil on bottom lands. The soil formed in calcareous silty alluvium. It is subject to frequent flooding. The areas of this soil range from 10 to 210 acres in size.

Typically, the surface layer is grayish brown, friable silt loam about 5 inches thick. The underlying material is dark grayish brown silty clay loam over grayish brown silt loam. It is stratified and contains iron segregations. The soil is calcareous above a depth of about 26 inches. Below that, there is a buried soil that is very dark gray, friable silty clay loam to a depth of more than 60 inches. In some areas the surface layer is not calcareous, or the color of the surface layer is not so dark. In some areas the soil is better drained.

Included with this soil in mapping are small areas of Aowa, Colo, and Hobbs soils. Aowa and Hobbs soils are well drained. Colo soils are somewhat poorly drained. These soils and the Kezan soil are in similar positions on the landscape. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The seasonal high water table ranges from a depth of about 1 foot in wet years to a depth of about 3 feet in dry years.

Most of the acreage of this soil is in introduced grasses for pasture, but some is dry-farmed.

Under dryland management, this soil is poorly suited to cultivated crops. Frequent flooding is the main hazard. Wetness is a limitation. Wetness delays tillage and planting operations in spring, particularly in wet years. Ditching can improve drainage. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth.

This soil is not suited to irrigation because of the combined effects of wetness and flooding.

This soil is suited to introduced or domesticated grasses for pasture. The most common grasses are smooth brome and bluegrass, but reed canarygrass and creeping foxtail are also suited. Deposition of sediment by floodwaters may partly cover the grasses and impede vigor and growth. Grazing when the water table is highest results in damage to the grassland, a rough surface, and difficulty in mowing hay. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. If the grasses are hayed, timely mowing helps to maintain high productivity.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of species that tolerate wetness are good. Hand planting in spring may be necessary because of wetness. Seedlings generally survive and grow well. Plant competition can be controlled by good site preparation and by timely cultivation or application of appropriate herbicides.

This soil is not suited to use as septic tank absorption fields and building sites because of flooding and wetness. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced by coarse base material. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage and from wetness caused by the seasonal high water table. Damage to roads by frost action can be reduced by providing good surface drainage and placing a gravel moisture barrier in the subgrade. Surface drainage is provided by crowning the road by grading and constructing adequate side ditches.

This soil is in capability unit IVw-4, dryland, in the Subirrigated range site, and in windbreak suitability group 2W.

#### **Lb—Lamo silty clay loam, 0 to 2 percent slopes.**

This is a deep, nearly level, somewhat poorly drained soil on bottom lands. The soil is occasionally flooded in early spring. It formed in silty alluvium. The areas of this soil range from 5 to 820 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer

is also very dark gray, friable silty clay loam; it is about 12 inches thick. A transitional layer is dark gray, firm silty clay loam about 15 inches thick. The underlying material is gray silty clay loam to a depth of more than 60 inches. The soil is calcareous throughout. In a few small areas the surface layer is silt loam. In a few small areas the surface layer is as much as 20 inches thick, and it does not have carbonates. Some areas are poorly drained.

Included with this soil in mapping are small areas of Aowa soils. Aowa soils are well drained and are adjacent to the waterway channels that intersect the Lamo soil. In some places there are small slick spots that are alkaline. The included soils make up about 10 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is slow. The organic matter content is moderate. This soil can be cultivated within only a fairly narrow range of moisture content without becoming compacted. The shrink-swell potential is high throughout. The water intake rate is low. The seasonal high water table ranges from a depth of about 1.5 feet in wet years to 3 feet in dry years.

About half of the acreage of this soil is cultivated, mainly dry-farmed. The rest is used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, and alfalfa. Occasional flooding is the main hazard. Wetness caused by the high water table is the main limitation. Flooding and wetness sometimes delay tillage and timely planting. Wetness also retards warming of the soil in spring. Management practices on nearby upland soils to control water runoff are needed to reduce wetness. Terraces, diversions, and conservation tillage help to retain precipitation on uplands. Grassed waterways can be constructed on or around this soil to confine runoff and to reduce flooding. Tile drains improve internal drainage if suitable outlets are available. Ditching helps to improve drainage. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. Land leveling helps to improve surface drainage and to increase the efficiency of an irrigation system. Flooding and wetness sometimes delay tillage and timely planting. Retaining precipitation on upland soils helps to prevent flooding on the Lamo soil and reduces wetness. Terraces, diversions, and conservation tillage help to retain precipitation on uplands. Grassed waterways can be constructed on or around this soil to confine runoff and to reduce flooding. Tile drains improve internal drainage if suitable outlets are available. Ditching also helps to improve drainage.



Figure 10.—Beef cattle grazing in an area of Lamo silty clay loam, 0 to 2 percent slopes.

Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced grasses or domesticated grasses for pasture (fig. 10). The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the water table is highest

results in damage to the grassland, a rough surface, and difficulty in mowing hay. Proper stocking rates, rotation grazing, and weed control are needed for highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to use as rangeland and native hayland. The natural plant community consists mainly of tall and mid grasses and grasslike plants dominated by big bluestem, little bluestem, indiangrass, switchgrass, prairie cordgrass, and various species of the sedge family. If the range is overgrazed or is hayed at an

improper time, and if the site has been overseeded and fertilized with nitrogen or phosphorus, the site may be dominated by redtop, foxtail barley, bluegrasses, alkali clover, sedges, and rushes. Overgrazing when the soil is wet in spring can result in surface compaction and small mounds; thus, harvesting hay is difficult.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival and growth rates are good for adapted species that tolerate wetness. Only those species that tolerate occasional wetness should be selected. Competition for moisture from weeds and grasses can be controlled by good site preparation through tillage or chemical methods prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled.

This soil is not suited to use as septic tank absorption fields. The limitations are flooding, wetness, and slow permeability. The soil is not suited to use as building sites. The limitations are flooding, wetness, and the high shrink-swell potential. An alternate site should be considered. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect the roads from flood damage and from wetness caused by the seasonal high water table. Roads need to be constructed so that the pavement and base material are thick enough to compensate for low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage and placing a gravel moisture barrier in the subgrade. Surface drainage is provided by crowning the road by grading and constructing adequate side ditches.

This soil is in capability units 1lw-4, dryland, and 1lw-3, irrigated; in the Subirrigated range site; and in windbreak suitability group 2S.

**Lc—Lamo silty clay loam, wet, 0 to 2 percent slopes.** This is a deep, nearly level, poorly drained soil on bottom lands. The soil formed in silty alluvium. It is subject to occasional flooding during periods of heavy rain. The areas of the soil range from 5 to 510 acres in size.

Typically, the surface layer is dark gray, friable silty clay loam about 4 inches thick. The subsurface layer is friable silty clay loam about 18 inches thick. It is very dark gray in the upper part and dark gray in the lower part. A transitional layer is gray, friable silty clay loam about 14 inches thick. The underlying material is gray silty clay loam to a depth of more than 60 inches. The soil is calcareous throughout. In some small areas the soils are somewhat poorly drained or very poorly drained. In some small areas there are loamy textures in the profile.

Included with this soil in mapping are small areas of Aowa and Kezan soils; these soils and the Lamo soil are in similar positions on the landscape. Aowa soils are stratified, are well drained, and are adjacent to a well defined waterway channel. Kezan soils are stratified and generally are adjacent to a poorly defined waterway channel crossing an area of the Lamo soil. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The shrink-swell potential is high throughout. The seasonal high water table ranges from a depth of 6 inches in wet years to about 18 inches in dry years.

Most of the acreage of this soil is used as rangeland.

This soil generally is not suited to farming, either dryland or irrigated. The limitations are the high water table, wetness, and slow runoff. This soil is drained in few places because suitable outlets generally are not available; thus, drainage by tile or surface shaping is difficult and expensive.

This soil is poorly suited to introduced grasses for pasture. Reed canarygrass is a suitable species. Excessive wetness limits the choice of pasture grasses and legumes. Grazing when the water table is highest results in damage to the grasses, a rough surface, and difficulty in mowing hay. Seeding grasses can be difficult because of wetness. Artificial drainage with V-ditches or perforated tile, where feasible, helps to reduce wetness caused by the high water table. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. Weeds can be controlled by spraying with appropriate herbicides.

This soil is suited to use as rangeland and native hayland. The natural plant community consists mainly of tall and mid grasses and grasslike plants dominated by switchgrass, indiagrass, big bluestem, prairie cordgrass, and sedges. If the soil is overgrazed or is hayed at an improper time or if the site has been overseeded, the site may be dominated by redtop, foxtail barley, alkali clover, sedges, and rushes. Overgrazing when the soil is wet can compact the surface and cause small mounds to form, which make grazing or harvesting hay difficult.

This soil generally is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival rate for adapted species is good. Because of wetness, seedlings can be difficult to establish in wet years. Only those species that tolerate occasional wetness should be selected. The soil should be tilled and seedlings planted only after the soil has become dry enough to be workable. Occasional flooding generally is not a severe problem. If necessary, surface drainage can be improved by installing a V-ditch and by land leveling.

This soil is not suited to use as septic tank absorption fields. The limitations are flooding, wetness, and slow permeability. The soil is also not suited to use as building

sites. The limitations are flooding, wetness, and the high shrink-swell potential. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Constructing roads on suitable, well-compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage and from wetness caused by the seasonal high water table.

This soil is in capability unit Vw-7, dryland, in the Wet Subirrigated range site, and in windbreak suitability group 2W.

**LoC—Loretto loam, sand substratum, 2 to 6 percent slopes.** This is a deep, gently sloping, well drained soil on uplands. The soil formed in loamy and silty loess over sand. The areas of the soil range from 5 to 295 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsurface layer is also very dark grayish brown, friable loam; it is about 3 inches thick. The subsoil is about 31 inches thick. In the upper part it is dark grayish brown, friable loam; in the middle part it is brown, friable silt loam; and in the lower part it is brown, friable, calcareous loam. The underlying material is pale brown, calcareous fine sand over coarse sand to a depth of more than 60 inches. In some small areas the surface layer is silt loam, and in some areas sand is at a depth of less than 40 inches. In some areas the dark color of the surface layer is dominant to a depth of more than 20 inches. In some areas the depth to sand is 55 inches or more.

Included with this soil in mapping are small areas of Moody, Ortello, and Thurman soils. Moody soils are silty throughout and are higher on the landscape than the Loretto soil. Ortello and Thurman soils and the Loretto soil are on similar landscapes. Ortello soils have less clay in the upper part of the profile than the Loretto soil. Thurman soils are sandy throughout. The included soils make up about 15 percent of the map unit.

Permeability is moderate in the solum and rapid in the underlying material. The available water capacity is moderate. Runoff is slow. The organic matter content is moderate. Tilth is good. The water intake rate is moderately low.

Most of the acreage of this soil is dry-farmed. The rest is used mainly as pastureland, and some is used as rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is a hazard. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. Grassed waterways, terraces, and contour farming help to control water erosion. A cropping system that includes grasses

and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and also to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. Water erosion is a hazard. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Such conservation practices as grassed waterways, terraces, and contour farming help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Light, frequent applications of irrigation water help to control erosion, to reduce loss of plant nutrients, and to ensure efficient water use.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The grass generally used is smooth bromegrass. Overgrazing by livestock or improper haying methods reduce productivity, the protective cover, and plant vigor. After heavy rains, small gullies and rills are common. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Irrigation water can be applied by a sprinkler system.

This soil is suited to use as rangeland and native hayland. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, indiagrass, sideoats grama, switchgrass, and western wheatgrass. If the range is overgrazed or is hayed at an improper time, the dominant plants may be blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the soil; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival is good and growth is fair for adapted species. Drought and competition for moisture from weeds and grasses are the major concerns. Irrigation during periods of low rainfall improves the survival rate of new plantings. Plant competition can be eliminated by good site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the



tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil generally is suited to use as septic tank absorption fields and as building sites. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material.

This soil is in capability units IIe-1, dryland, and IIle-4, irrigated; in the Silty range site; and in windbreak suitability group 3.

**LoD—Loretto loam, sand substratum, 6 to 11 percent slopes.** This is a deep, strongly sloping, well drained soil on uplands. The soil formed in loamy loess over sand. The areas of the soil range from 5 to 130 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The subsurface layer is also dark grayish brown, friable loam; it is also about 8 inches thick. The subsoil is about 26 inches thick. In the upper part it is brown, friable loam, and in the lower part it is brown, friable sandy loam. The underlying material is light yellowish brown, calcareous loamy sand to a depth of more than 60 inches. In some areas the slope is slightly less than 6 percent. In some small areas the surface layer is silt loam or sand is at a depth of less than 40 inches. In some areas the dark colors of the surface layer are dominant to a depth of more than 20 inches.

Included with this soil in mapping are small areas of Moody, Ortello, and Thurman soils. Moody soils are silty throughout and are higher on the landscape than the Loretto soil. Ortello soils have less clay in the upper part of the profile than the Loretto soil. Ortello and Thurman soils and the Loretto soil are in similar positions on the landscape. The included soils make up about 15 percent of the map unit.

Permeability is moderate in the solum and rapid in the underlying material. The available water capacity is moderate. Runoff is medium. The organic matter content is moderate. Tilth is good. The water intake rate is moderately low.

Most of the acreage of this soil is dry-farmed, but some is irrigated. The rest is used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter

content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is poorly suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. The main hazard is water erosion. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. The hazard of water erosion requires careful water application to prevent loss of soil productivity and crop damage.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity, damage the protective cover, and cause poor plant vigor. As a result, small gullies and rills are common after heavy rains. Rotation grazing and fertilization are needed for the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Irrigation water can be applied by a sprinkler system.

This soil is suited to use as rangeland and native hayland. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, indiagrass, sideoats grama, switchgrass, and western wheatgrass. If the range is overgrazed or hayed at an improper time, the range site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. In addition, woody plants may migrate to or invade the site; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival is good and growth is fair for adapted species. Drought and competition for moisture from weeds are the major hazards. Irrigation can supply moisture during periods of low rainfall. Plant competition can be eliminated by good site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can be eliminated by hand hoeing, rototilling, and use of appropriate herbicides.

Land shaping and installing a septic tank absorption field on the contour generally are necessary for proper operation of the absorption field. Buildings should be designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units IIIe-1, dryland, and IVe-4, irrigated; in the Silty range site; and in windbreak suitability group 3.

**Ma—Maskell loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on terraces and alluvial fans. The soil formed in loamy alluvial material. The areas of the soil range from 5 to 110 acres in size.

Typically, the surface layer is very dark grayish brown, very friable loam about 8 inches thick. The subsurface layer is very dark brown, very friable loam about 17 inches thick. The subsoil is about 26 inches thick. It is very dark grayish brown, very friable loam in the upper part; dark grayish brown, friable sandy clay loam in the middle part; and brown, friable sandy loam in the lower part. The underlying material is brown sandy loam to a depth of more than 60 inches. In places there is a buried soil at a depth of as little as 24 inches; it can extend to a depth of more than 60 inches. In some small areas the surface layer or subsurface layer or both are silt loam or the underlying material is sandy.

Included with this soil in mapping are small areas of Nimbro soils. Nimbro soils are stratified and are in the lowest positions where waterways intersect the mapped areas of the Maskell soil. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderately low.

Most of the acreage of this soil is dry-farmed, but some areas are irrigated. The rest is used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Properly designed and maintained grassed waterways can carry runoff from nearby upland soils across areas of this soil at a nonerosive velocity.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems are suited to this soil. In some places leveling may be required for a gravity system. Conservation tillage, such as no-till planting, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Properly designed and maintained grassed waterways can carry runoff from nearby uplands across areas of this soil at a nonerosive velocity.

This soil is suited to introduced or domesticated grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Rotation grazing, proper stocking rates, and fertilization help to maintain the grasses in good condition and are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to use as rangeland and native hayland. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, sideoats grama, switchgrass, and western wheatgrass. If the range is overgrazed or is hayed at an improper time, the site may be dominated by western wheatgrass, Kentucky bluegrass, tall dropseed, and numerous annual and perennial broadleaf weeds. In addition, woody plants may migrate to the site; these include buckbrush and snowberry. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival is good and growth is fair for adapted species. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation during periods of low rainfall can improve the survival rate of new plantings. Plant competition can be eliminated by site preparation through tillage or chemical methods prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can be eliminated by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled.

This soil generally is suited to use as septic tank absorption fields. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads need to be designed so that the pavement and base material are thick enough to compensate for the

low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units I-1, dryland, and I-4, irrigated; in the Silty Lowland range site; and in windbreak suitability group 1.

**MaC—Maskell loam, 2 to 6 percent slopes.** This is a deep, gently sloping, well drained soil on terraces and foot slopes. The soil formed in loamy alluvium and colluvium. The areas of the soil range from 5 to 205 acres in size.

Typically, the surface layer is dark grayish brown, friable loam about 6 inches thick. The subsurface layer is also friable loam, and it is about 12 inches thick. It is dark grayish brown over very dark grayish brown. The subsoil is about 32 inches thick. In the upper part it is very dark grayish brown, friable loam; in the middle part it is dark grayish brown, friable clay loam; and in the lower part it is brown, firm clay loam. The underlying material is pale brown loam to a depth of more than 60 inches. In some small areas, the texture of the surface layer or of some subhorizon or of both is silt loam, or the underlying material is sandy.

Included with this soil in mapping are small areas of Loretto and Nimbro soils. Loretto soils and the Maskell soil are in similar positions on the landscape, but Loretto soils do not have a thick, dark colored surface soil. Nimbro soils are stratified and are in the lowest positions adjacent to drainageways that intersect areas of the Maskell soil. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is medium. The organic matter content is moderate. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderately low.

Most of the acreage of this soil is dry-farmed, but some is irrigated. The rest is used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. The surface needs to be protected by an adequate cover consisting of a growing crop, crop residue, or both. Conservation tillage, such as no-till planting, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. Water erosion is the main hazard. The surface needs to be protected by an adequate plant cover

consisting of a growing crop, crop residue, or both. Conservation tillage, such as no-till planting, disking, or chiseling, which keeps all or part of the crop residue on the surface, helps to control water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Light, frequent applications of irrigation water help to control erosion, to reduce loss of plant nutrients, and to promote efficient water use.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity, damage the protective cover, and cause poor plant vigor. As a result, small gullies and rills are common after heavy rains. Rotation grazing, proper stocking rates, and fertilization help to maintain the grasses in good condition and are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to use as rangeland and native hayland. These uses are effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, sideoats grama, switchgrass, and western wheatgrass. If the range site is overgrazed or is hayed at an improper time, the site may be dominated by western wheatgrass, Kentucky bluegrass, tall dropseed, and numerous annual and perennial broadleaf weeds. In addition, woody plants may migrate to the site; these include buckbrush and snowberry. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival is good and growth is fair for adapted species. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation can supply moisture during periods of low rainfall. Plant competition can be eliminated by site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the tree rows can also be eliminated by hand hoeing, rototilling, and use of appropriate herbicides.

The soil generally is suited to use as septic tank absorption fields. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil.



Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units IIe-1, dryland, and IIle-4, irrigated; in the Silty range site; and in windbreak suitability group 3.

**Mm—Modale silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, moderately well drained soil on bottom lands. The soil is subject to rare flooding. The areas of this soil range from 10 to 275 acres.

Typically, the surface layer is grayish brown, friable silt loam about 9 inches thick. The underlying material in the upper part is light gray silt loam about 20 inches thick. In the lower part it is grayish brown silty clay that is mottled to a depth of more than 60 inches. In some small areas the surface layer is silty clay loam or very fine sandy loam. In some places the soil is silty to a depth of less than 18 or more than 30 inches.

Included with this soil in mapping are small areas of Albaton and Blake soils. Albaton soils are in the lowest depressional positions and have more clay in the upper part of the profile than the Modale soil. Blake soils and the Modale soil are on similar landscapes. Blake soils have more silt and less clay in the lower part of the profile. The included soils make up about 10 percent of the map unit.

Permeability is moderate in the upper part of the profile and very slow in the lower part. The available water capacity is high. The organic matter content is moderately low. Runoff is slow. Tilth is good. The water intake rate is moderate. The seasonal high water table is at a depth ranging from about 3 feet in wet years to 4 feet in dry years.

Most of the acreage of this soil is dry-farmed, but some is irrigated.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems are suited to this soil. Land leveling helps to improve the efficiency of an irrigation system. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to conserve soil moisture. A cropping system that includes grasses and legumes, returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the

organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Survival is good and growth is fair for adapted species. Drought and competition for moisture from weeds and grasses are the major hazards. Irrigation during periods of low rainfall improves the survival rate of new plantings. Plant competition can be eliminated by site preparation through tillage or chemical methods prior to planting and by timely cultivation between rows with conventional equipment. Plant competition in the rows can be eliminated by careful use of appropriate herbicides and by hand hoeing or rototilling.

This soil is not suited to use as septic tank absorption fields because of wetness and the very slow permeability. An alternate site should be considered. Buildings can be constructed on elevated, well compacted fill material to prevent damage by flooding and by wetness caused by the high water table. Buildings need to be strengthened and backfilled with coarse material to prevent damage caused by the shrinking and swelling of the soil. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage and placing a gravel moisture barrier in the subgrade. Good surface drainage is provided by crowning the road by grading and by constructing adequate side ditches.

This soil is in capability units I-1, dryland, and I-6, irrigated; in the Silty Lowland range site; and in windbreak suitability group 1.

**Mo—Moody silty clay loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on uplands. The soil formed in loess. The areas of this soil range from 10 to 1,320 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 9 inches thick. The subsurface layer is also dark grayish brown, friable silty clay loam; it is about 3 inches thick. The subsoil is friable silty clay loam about 34 inches thick. The upper part is brown, and the lower part is yellowish brown. The underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches. In some small areas the dark color of the surface layer is dominant to a depth of 20 to 30 inches.

Included with this soil in mapping are small areas of Fillmore soils. Fillmore soils are in shallow depressions, have more clay in the subsoil than the Moody soil, are poorly drained, and are occasionally ponded. Also included are small areas of somewhat poorly drained soils in shallow depressions. The included soils make up about 10 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The rate of water intake is low.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some are irrigated. A few small areas are in introduced grasses.

Under dryland management, this soil is suited to corn, soybeans, grain sorghum, oats, and alfalfa. Conservation of water is an important concern in management. Conservation tillage, such as no-till, which keeps crop residue on the surface, helps to conserve moisture for use by crops. Lime is needed to correct the acidity if alfalfa is grown.

Under irrigation, this soil is suited to row crops, such as corn and soybeans, and to close-grown crops, such as alfalfa. Center pivot irrigation systems are well suited. The application rate of water needs to be adjusted to the rate of water intake. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or to improve the organic matter content, fertility, and tilth and also to increase the infiltration of water. Lime is needed to correct the acidity if alfalfa is grown.

This soil is suited to introduced grasses for pasture. Pastures commonly consist of smooth brome grass and alfalfa. Rotation grazing, nitrogen fertilizer, and proper stocking rates help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Cultivation between the tree rows and hand hoeing in the rows or careful use of appropriate herbicides helps to control weeds. Newly planted trees may need watering during periods of insufficient rainfall.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields. This limitation, however, can generally be overcome by increasing the size of the absorption field. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with a coarse-grained base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units I-1, dryland, and I-3, irrigated; in the Silty range site; and in windbreak suitability group 3.

**MoC2—Moody silty clay loam, 2 to 6 percent slopes, eroded.** This is a deep, gently sloping, well drained soil on side slopes and ridgetops on uplands.

The soil formed in loess. The areas of the soil range from 10 to 1,250 acres in size.

Typically, the surface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is silty clay loam about 39 inches thick. In the upper part it is friable and dark grayish brown, in the middle part it is firm and brown, and in the lower part it is friable and pale brown. The underlying material is pale brown, calcareous silt loam to a depth of more than 60 inches. In some pedons the underlying material is loamy below a depth of 40 inches. In some areas the dark color of the surface layer is dominant to a depth of 10 to 15 inches. In some small areas calcium carbonates are above a depth of 30 inches.

Included with this soil in mapping are small areas of Alcester, Loretto, and Thurman soils. Alcester soils are in concave positions in upland drainageways. The dark colors of the surface layer of Alcester soils are dominant to a depth of more than 20 inches. Loretto soils have more sand in the subsoil and underlying material than the Moody soil; they and the Moody soil are on similar landscapes. Thurman soils, which are sandy, are in widely scattered areas. The included soils make up about 10 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is medium. The organic matter content is moderate. Tilth is good. The intake rate of water is low.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some areas are irrigated. A few small areas are in introduced grasses.

Under dryland management, this soil is suited to corn, soybeans, oats, and alfalfa. Water erosion is the main hazard. In most areas, erosion has removed part of the original dark surface layer and tillage has mixed the upper part of the subsoil with the remaining surface layer. Rills and gullies are common after heavy rains. Water conservation is an important concern in management. Row crops can be grown on the contour. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Terraces and grassed waterways help to control erosion and to conserve water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works well on this soil (fig. 11). Erosion is the major hazard. Adjusting the application rate of water to the water intake rate of the soil helps to prevent runoff and to control soil erosion. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve moisture. Returning crop residue to the soil and applying feedlot manure to



**Figure 11.—A center pivot sprinkler irrigation system is in use on a cornfield in an area of Moody silty clay loam, 2 to 6 percent slopes, eroded. Sprinkler irrigation allows very fine control of the rate at which water is applied.**

the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced grasses for pasture. Pastures consist mainly of smooth brome. Proper stocking rates, rotation grazing, and nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Plant competition can be controlled by cultivation between the rows, by hand hoeing in the rows, or by careful use of appropriate herbicides. Newly planted trees may need watering during periods of insufficient rainfall.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields. This limitation

generally can be overcome by increasing the size of the absorption field. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Small commercial buildings should be designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage. Good surface drainage is provided by crowning the road by grading and by constructing adequate side ditches.

This soil is in capability units IIe-8, dryland, and IIIe-3, irrigated; in the Silty range site; and in windbreak suitability group 3.

**MoD2—Moody silty clay loam, 6 to 11 percent slopes, eroded.** This is a deep, strongly sloping, well drained soil on lower side slopes and at the head of drainageways on uplands. The soil formed in loess. The areas of this soil range from 5 to 150 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 48 inches thick. The upper part is brown, the middle part is pale brown, and the lower part is light yellowish brown. The underlying material is light yellowish brown, calcareous silt loam to a depth of more than 60 inches. In some areas the surface layer is more than 10 inches thick.

Included with this soil in mapping are small areas of Alcester and Crofton soils. Alcester soils are on lower foot slopes and have dark colors to a depth of more than 20 inches. Crofton soils are in the more convex areas and are calcareous at or near the surface. The included soils make up about 10 percent of the map unit.

Permeability is moderately slow. The available water capacity is high. Runoff is medium. The organic matter content is moderate. Tilth is good. The water intake rate is low.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some are irrigated. A few small areas are in introduced grasses.

Under dryland management, this soil is suited to corn, soybeans, oats, and alfalfa. Water erosion is the main hazard. In most areas erosion has removed part of the original dark surface layer and tillage has mixed the upper part of the subsoil with the remaining surface layer. Rills and gullies are common after heavy rains. Water conservation is an important concern in management. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve soil moisture. Returning crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Terraces, contour farming, grassed waterways, and crop rotations help to control erosion and to conserve water.

Under irrigation, this soil is suited to alfalfa. It is poorly suited to such row crops as corn and soybeans. The major hazard is water erosion. A sprinkler irrigation system works well on this soil. Adjusting the application rate of water to the water intake rate of the soil helps to prevent runoff and to control erosion. Conservation tillage, such as no-till planting, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve moisture. Returning crop residue to the soil and applying feedlot manure to the soil helps to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Contour farming, terraces, and grassed waterways help to control erosion and to conserve water.

This soil is suited to introduced grasses for pasture. Pastures consist mainly of smooth brome. Proper stocking rates, rotation grazing, and nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Weeds can be controlled by cultivation between the rows, by hand hoeing, or by careful use of appropriate herbicides in the rows. Erosion can be controlled by planting trees on the contour in combination with terraces. Newly planted trees may need watering during periods of insufficient rainfall.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields. This limitation generally can be overcome by increasing the size of the absorption field. Land shaping and installing the absorption field on the contour generally is necessary for proper operation. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by the shrinking and swelling of the soil. Buildings should be designed to accommodate the slope, or the soil can be graded. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IIIe-1, dryland, and IVE-3, irrigated; in the Silty range site; and in windbreak suitability group 3.

**Nb—Nimbro silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on bottom lands. It is occasionally flooded for brief periods, usually late in winter and early in spring. The soil formed in silty and loamy alluvium. The areas of this soil range from 5 to 240 acres in size.

Typically, the surface layer is stratified grayish brown, friable silt loam about 7 inches thick. The underlying material is stratified, grayish brown silt loam over pale brown loam to a depth of 56 inches. Below that, to a depth of more than 60 inches, there is a buried soil of dark grayish brown and pale brown loam. In some places there are no calcium carbonates throughout the profile. In some small areas the soil is sandy above a depth of 40 inches.

Included with this soil in mapping are small areas of Blendon and Maskell soils. Blendon and Maskell soils are not stratified and are in slightly higher positions on the landscape. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is

moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed, and some is irrigated. The remainder is used as pasture and rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Flooding is the main hazard. Flood damage to crops is seldom severe. Flooding can be reduced by retaining precipitation on upland soils. Terraces, diversions, and conservation tillage on nearby upland soils help to retain precipitation and to prevent runoff from flooding the Nimbro soil. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works well on this soil. Flooding is the main hazard. Flood damage to crops is seldom severe. Terraces, diversions, and conservation tillage on nearby upland soils help to retain precipitation and to prevent runoff. Conservation tillage, such as no-till planting, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Rotation grazing and fertilization are needed to achieve the highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland and native hayland. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and western wheatgrass. If the range site is overgrazed or is hayed at an improper time, the site may be dominated by western wheatgrass, Kentucky bluegrass, and numerous annual and perennial broadleaf weeds. Also, woody plants may migrate to the site; these include snowberry and buckbrush. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival rates and growth of adapted species are good. The main hazard is competition for moisture from weeds

and grasses. Plant competition can be eliminated by site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment between the rows. Plant competition in the rows can be eliminated by hand hoeing, rototilling, and use of appropriate herbicides.

This soil is not suited to septic tank absorption fields and building sites because of flooding. An alternate site should be considered. Roads need to be constructed so that the pavement and the base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Constructing roads on suitable, well compacted fill material above flood level and constructing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units 11w-4, dryland, and 11w-6, irrigated; in the Silty Overflow range site; and in windbreak suitability group 1L.

**NrD2—Nora silty clay loam, 6 to 11 percent slopes, eroded.** This is a deep, strongly sloping, well drained soil on side slopes on uplands. The soil formed in loess. Water erosion is a hazard. The areas of this soil range from 10 to 700 acres in size.

Typically, the surface layer is brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam 21 inches thick. In the upper part it is brown, and in the lower part it is pale brown and calcareous. The underlying material is calcareous silt loam to a depth of more than 60 inches. It is pale brown in the upper part, light brownish gray in the middle part, and light gray in the lower part. In some areas calcium carbonates are not present above a depth of 30 inches. In other small areas the surface layer is 7 to 10 inches thick.

Included with this soil in mapping are small areas of Alcester and Crofton soils. Alcester soils are on lower foot slopes and are dark-colored to a depth of more than 20 inches. Crofton soils are on convex upper slopes and narrow ridgetops and are calcareous at or near the surface. The included soils make up about 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is medium. The organic matter content is moderate. Tilth is good. The water intake rate is low.

Most of the acreage of this soil is farmed. Most areas are dry-farmed, but some are irrigated. A few small areas are in introduced grasses.

Under dryland management, this soil is suited to corn, soybeans, oats, and alfalfa. Water erosion is the main hazard. In places erosion has removed part of the surface layer and tillage has mixed the upper part of the subsoil with the remaining surface layer. Water conservation is an important concern in management. Conservation tillage, such as no-till planting, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve soil moisture. Returning



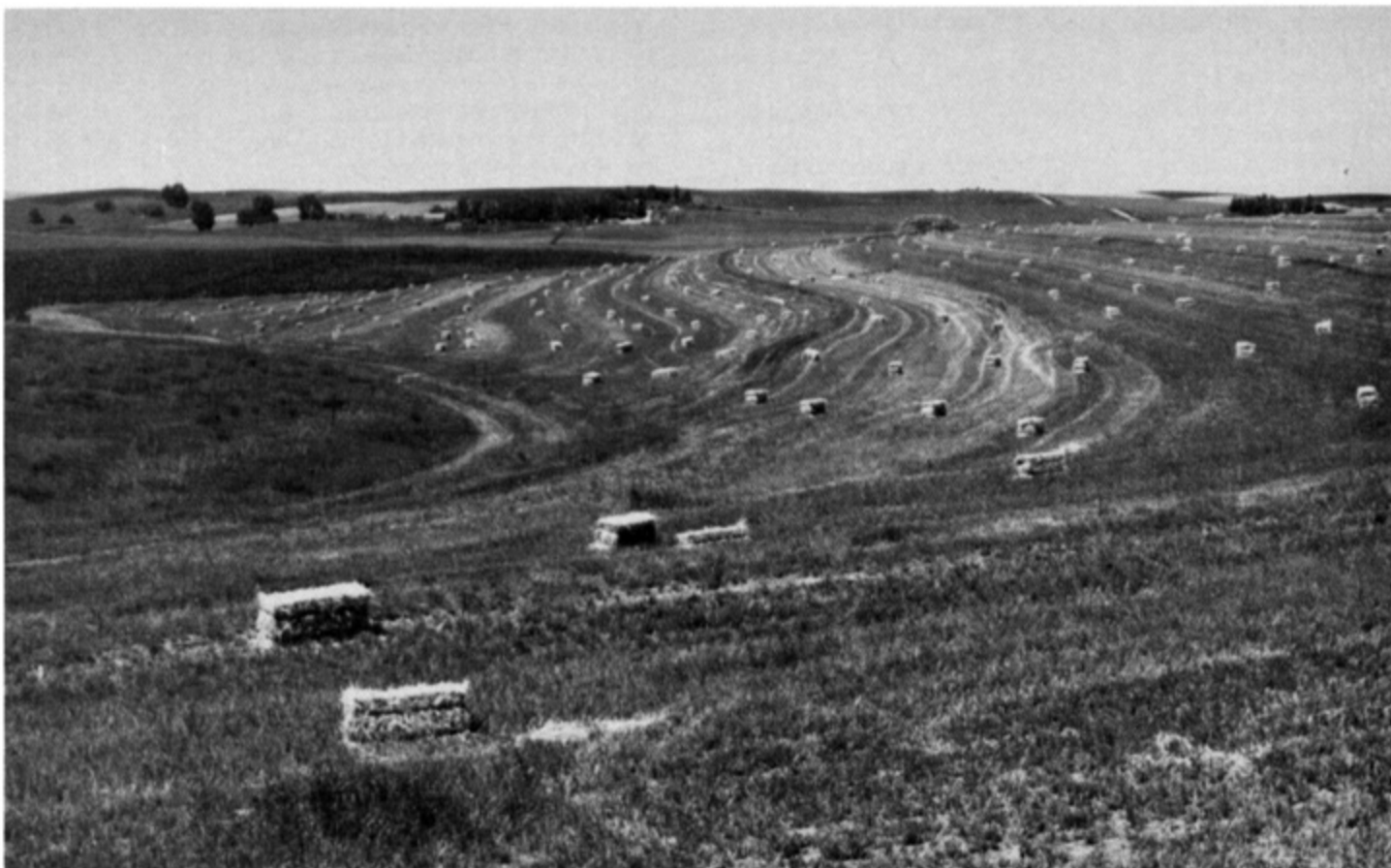


Figure 12.—Terraces, contour farming, and a cropping sequence that includes hay crops help to control erosion on Nora silty clay loam, 6 to 11 percent slopes, eroded.

crop residue to the soil, growing green manure crops, and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Terraces, contour farming, grassed waterways, and crop rotations help to control erosion and to conserve water.

Under irrigation, this soil is suited to alfalfa. It is poorly suited to row crops, such as corn and soybeans. The major hazard is erosion. A sprinkler irrigation system works well on this soil. Adjusting the application rate of water to the water intake rate of the soil helps to prevent runoff and to control erosion. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, helps to prevent erosion and to conserve moisture. Returning crop residue to the soil and applying feedlot manure to the soil help to maintain or improve the organic matter content, fertility, and tilth and to improve the infiltration of water. Contour farming, terraces, and grassed waterways help to control erosion (fig. 12).

This soil is suited to introduced grasses for pasture. Pastures consist mainly of smooth brome grass. Proper stocking rates, rotation grazing, and nitrogen fertilizer help to keep the grasses in good condition.

This soil is suited to trees and shrubs in windbreaks. Healthy seedlings of adapted species, properly planted in a well prepared site, usually survive and grow well. Weeds can be controlled by cultivation between the rows, by hand hoeing, or by careful use of appropriate herbicides in the rows. Erosion can be controlled by planting trees on the contour in combination with terraces. Newly planted trees may need watering during periods of insufficient rainfall.

Land shaping and installing a septic tank absorption field on the contour generally are necessary for proper operation of the absorption field. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage by shrinking and swelling of the soil. Buildings should be designed to accommodate the slope, or the soil can be graded.

Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IIIe-8, dryland, and IVe-3, irrigated; in the Silty range site; and in windbreak suitability group 3.

**On—Onawa silty clay, 0 to 2 percent slopes.** This is a deep, nearly level, somewhat poorly drained soil on bottom lands. It is subject to rare flooding. This soil formed in clayey over silty and loamy alluvium. The areas of this soil range from 10 to 200 acres in size.

Typically, the surface layer is dark gray, firm silty clay about 8 inches thick. The underlying material is mottled, gray silty clay to a depth of 22 inches; below that, it is grayish brown and light brownish gray silt loam to a depth of 60 inches or more. The soil is calcareous throughout. In some small areas the surface layer is silty clay loam or silt loam. In some places the soil is clayey to a depth of less than 18 inches or of more than 30 inches. In a few areas the soil is thickly stratified with clayey and silty textures throughout, so that the typical contrast of clayey over loamy texture is not present in the profile.

Included with this soil in mapping are small areas of Albaton, Modale, and Percival soils. Albaton soils are in the lowest depressional positions on the landscape and have more clay in the lower part of the profile. Modale and Percival soils and the Onawa soil are in similar positions on the landscape. Modale soils are more silty in the upper part and more clayey in the lower part of the profile than the Onawa soil. Percival soils are sandy in the lower part of the profile. The included soils make up about 15 percent of the map unit.

Permeability is slow in the upper part of the Onawa soil and moderate in the lower part. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is poor, and tilling this soil is difficult; a critical factor is the narrow range of moisture content within which the soil can be tilled without becoming compacted. The shrink-swell potential is high in the upper part and moderate in the lower part. The water intake rate is low. The seasonal high water table is at a depth of about 2 feet in wet years to 4 feet in dry years.

Most of the acreage of this soil is dry-farmed. A few areas are irrigated.

Under dryland management, this soil is suited to corn, soybeans, and alfalfa. The main limitations are excessive wetness and poor tilth. Wetness sometimes delays spring tillage, but not so long as to miss optimum planting dates. Excessive wetness can be overcome by land leveling and drainage ditching if outlets are

available. Tilth can be improved by incorporating crop residue into the soil and tilling only when the moisture content is optimum. Crop stress during a drought is compounded by the cracks that form as the soil loses water. The cracking injures plant roots and accelerates drying. Cultivation reduces cracking and fills the cracks. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Gravity and sprinkler irrigation systems work well on this soil. Land leveling helps to improve surface drainage and increases the efficiency of an irrigation system. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Timely application of water is critical for efficient water management. The soil should be wet to near maximum field capacity at the beginning of the period of maximum water use to avoid crop stress.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. Tree and shrub species that tolerate occasional wetness generally survive and grow well. Cracking in summer caused by the high shrink-swell potential and competition for moisture from weeds and grasses can be controlled by site preparation through tillage or chemical methods prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can also be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled. Light cultivation and supplemental watering can close the cracks.

The hazard of rare flooding is a limitation to the use of this soil for sanitary facilities and buildings. Septic tank absorption fields can be constructed on fill material so that the absorption field is above the seasonal high water table. Buildings constructed on elevated, well compacted fill material are protected against flooding and against wetness caused by the high water table. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Good surface drainage



is provided by crowning the road by grading and by constructing adequate side ditches.

This soil is in capability unit llw-1, dryland and irrigated; in the Clayey Overflow range site; and in windbreak suitability group 2S.

**OrC—Ortello sandy loam, 2 to 6 percent slopes.**

This is a deep, gently sloping, well drained soil on uplands. The soil formed in loamy and sandy eolian material. The areas of this soil range from 5 to 60 acres in size.

Typically, the surface layer is dark grayish brown, friable sandy loam about 5 inches thick. The subsurface layer is also dark grayish brown, friable sandy loam; it is about 4 inches thick. The subsoil is 23 inches thick and is sandy loam. In the upper part it is dark brown and friable, in the middle part it is brown and friable, and in the lower part it is brown and very friable. The underlying material is light yellowish brown loamy sand to a depth of more than 60 inches. In some areas silt loam, sand, or coarse sand is below a depth of 40 inches. In some areas the dark color of the surface layer is dominant to a depth of more than 20 inches. In some areas calcium carbonates have not been leached from the lower part of the soil and are at a depth as shallow as 20 inches.

Included with this soil in mapping are small areas of Loretto and Thurman soils. Loretto and Thurman soils and the Ortello soil are in similar positions on the landscape. Loretto soils have more clay in the subsoil. Thurman soils are sandy throughout. The included soils make up about 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Runoff is slow. The organic matter content is moderately low. Tilth is good, and this soil is easily tilled within a wide range of moisture content. The water intake rate is moderately high.

Most of the acreage of this soil is dry-farmed, but some is irrigated. The rest is used mainly as pastureland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion and soil blowing are the main hazards. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works well on this soil. The major hazards are water erosion and soil blowing. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help

to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Irrigation water must be carefully applied to conserve water, to minimize water erosion, and to prevent the loss of soil productivity and damage to crops.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion and soil blowing. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity and the protective cover and cause poor plant vigor. As a result, small gullies and rills are common after heavy rains. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide grazing over a long season.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Competition for moisture from weeds and grasses is the major hazard. Irrigation can supplement moisture during periods of low rainfall. Plant competition can be controlled by site preparation by tillage or chemical methods prior to planting and by timely cultivation between the tree rows with conventional equipment. Hand hoeing, rototilling, and appropriate herbicides in the tree rows can also be used.

This soil readily absorbs the effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. This soil generally is suited to use as building sites. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units Ille-3, dryland, and Ille-8, irrigated; in the Sandy range site; and in windbreak suitability group 5.

**OrD—Ortello sandy loam, 6 to 11 percent slopes.**

This is a deep, strongly sloping, well drained soil on uplands. The soil formed in loamy and sandy eolian material. The areas of the soil range from 5 to 95 acres in size.

Typically, the surface layer is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 7 inches thick. The subsoil is about 21 inches thick. It is brown, friable fine sandy loam in the upper part and pale brown, very friable loamy fine sand in the lower part. The underlying material is pale brown and very pale brown loamy fine sand to a depth of more than 60 inches. In

some areas silt loam, sand, or coarse sand is within a depth of 40 inches. In some areas the dark color of the surface layer is dominant to a depth of less than 8 inches, and in other small areas it extends to a depth of more than 20 inches. In some areas calcium carbonates have not been leached from the lower part of the soil and are at a depth as shallow as 20 inches.

Included with this soil in mapping are small areas of Loretto, Nora, and Thurman soils. These soils and the Ortello soil are in similar positions on the landscape. Loretto soils have more clay above a depth of 40 inches. Nora soils are silty throughout. Thurman soils are sandy throughout. The included soils make up about 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Runoff is medium. The organic matter content is moderately low. Tilth is good, and the soil is easily tilled within a wide range of moisture content. The water intake rate is moderately high.

Most of the acreage of this soil is dry-farmed, but some is irrigated. The rest is used mainly as pasture, and some is used as rangeland.

Under dryland management, this soil is poorly suited to corn, soybeans, alfalfa, and oats. Water erosion and soil blowing are the main hazards. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is poorly suited to corn and soybeans. It is suited to alfalfa. A sprinkler irrigation system works well on this soil. The major hazards are water erosion and soil blowing. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to control water erosion and soil blowing and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Irrigation water must be carefully applied to minimize water erosion, to conserve water, and to prevent crop damage and the loss of soil productivity. Careful application of irrigation water is needed for water conservation and for maintenance required.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion and soil blowing. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce

productivity, damage the protective cover, and cause poor plant vigor. As a result, small gullies and rills are common after heavy rains. Such practices as rotation grazing and fertilization are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling soil blowing and water erosion. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the soil is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue grama, purple lovegrass, sand dropseed, and western ragweed increase.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Competition for moisture from weeds and grasses is the major hazard. Irrigation during periods of low rainfall improves the survival rate of new plantings. Plant competition can be controlled by site preparation, by tillage or chemical methods prior to planting, and by timely cultivation between the tree rows with conventional equipment. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. Buildings should be designed to accommodate the slope, or the soil can be graded. Cutting and filling generally are needed to provide a suitable grade for roads. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

This soil is in capability units IVe-3, dryland, and IVe-8, irrigated; in the Sandy range site; and in windbreak suitability group 5.

#### **OrE—Ortello sandy loam, 11 to 15 percent slopes.**

This is a deep, moderately steep, well drained soil on uplands. The soil formed in loamy and sandy eolian material. The areas of the soil range from 10 to 70 acres in size.

Typically, the surface layer is dark grayish brown, friable sandy loam about 5 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 4 inches thick. The subsoil is brown, friable fine sandy loam about 20 inches thick. The underlying material is yellowish brown and brown fine sandy loam to a depth of more than 60 inches. In some small areas silt loam,

sand, or coarse sand is above a depth of 40 inches. In some small areas the dark color of the surface layer is dominant to a depth of less than 8 inches. In some areas calcium carbonates are at a depth as shallow as 20 inches.

Included with this soil in mapping are small areas of Crofton and Nora soils. These soils and the Ortello soil are in similar positions on the landscape. Crofton soils are silty throughout and are calcareous higher in the profile than the Ortello soil. Nora soils are silty throughout. The included soils make up about 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Runoff is medium. Tilth is good. The organic matter content is moderately low. The water intake rate is moderately high.

Most of the acreage of this soil is used as pasture and rangeland. This soil is not suited to use as cropland.

This soil is suited to introduced or domesticated grasses for permanent pasture. This use is effective in controlling water erosion and soil blowing. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity, damage the protective cover, and reduce plant vigor. As a result, small gullies and rills are common after heavy rains. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling soil blowing and water erosion. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the range site is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue grama, purple lovegrass, sand dropseed, and western ragweed increase.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Competition for moisture from weeds and grasses is the major hazard. Irrigation during periods of low rainfall improves the survival rate of new plantings. Plant competition can be controlled by site preparation, by tillage or chemical methods prior to planting, and by timely cultivation between the rows with conventional equipment. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capability may result in

pollution of the underground water table. Buildings should be designed to accommodate the slope, or the soil can be graded. Cutting and filling generally are needed to provide a suitable grade for roads and streets. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads and streets by frost action is reduced or prevented.

This soil is in capability unit Vle-3, dryland, in the Sandy range site, and in windbreak suitability group 5.

**Pe—Percival silty clay, 0 to 2 percent slopes.** This is a deep, nearly level, somewhat poorly drained soil on bottom lands. It is subject to rare flooding. The soil formed in clayey over sandy alluvium. The areas of the soil range from 5 to 340 acres.

Typically, the surface layer is dark gray, firm silty clay about 8 inches thick. The underlying material is grayish brown silty clay to a depth of 19 inches. Below that, it is light brownish gray and light gray fine sand to a depth of more than 60 inches. The soil is calcareous throughout the profile. In some small areas the surface layer is silt loam or silty clay loam. In some small areas the soil is clayey to a depth of less than 15 inches or of more than 30 inches.

Included with this soil in mapping are small areas of Grable and Sarpy soils. Grable and Sarpy soils are in the highest positions in the mapped areas. Grable soils are well drained and are silty in the upper part of the profile. Sarpy soils are excessively drained and are sandy throughout the profile. The included soils make up about 10 percent of the map unit.

Permeability is slow in the upper part of the Percival soil and rapid in the lower part. The available water capacity is low. Runoff is slow. The organic matter content is moderately low. Tilth is poor, and the soil is difficult to till; a critical factor is the narrow range of moisture content within which the soil can be tilled without damage to the soil structure. The shrink-swell potential is high in the upper part and low in the lower part. The water intake rate is very low. The seasonal high water table ranges from a depth of about 2 feet in wet years to 4 feet in dry years.

Most of the acreage of this soil is dry-farmed.

Under dryland management, this soil is suited to corn, soybeans, and alfalfa. The main limitation is excessive wetness in spring. In some years, wetness delays tillage, but not so long as to miss optimum planting dates. Excessive wetness can be overcome by land leveling and drainage ditching if outlets are available. Tilth can be improved by incorporating crop residue into the soil. Crop stress during drought is compounded by the low available water capacity and the cracking of the surface soil that occurs as the soil loses water. The cracking injures plant roots and accelerates drying. Cultivation reduces cracking and fills the cracks. Conservation tillage, such as no-till, which keeps all or part of the crop

residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. Land leveling helps to improve surface drainage and increases the efficiency of an irrigation system. Conservation tillage, which keeps part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water. Timely application of water is needed for efficient water management.

This soil is suited to trees and shrubs in windbreaks. The survival rate is good and growth is fair for adapted species. Cracking in summer caused by the high shrink-swell potential of the soil and competition for moisture from weeds and grasses are concerns in management. They can be controlled by site preparation through tillage or chemical methods prior to planting and by timely cultivation between the rows with conventional equipment. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed by hand or rototilled. Light cultivation and supplemental watering can close the cracks.

The hazard of rare flooding is a limitation to the use of this soil for sanitary facilities and buildings. Septic tank absorption fields can be constructed on fill material well above the seasonal high water table. Care should be taken to be certain that seepage from an absorption field does not contaminate the underground water table and water supply, because the sandy underlying material does not adequately filter the effluent. Constructing buildings on elevated, well compacted fill material helps to protect buildings from flood damage and wetness caused by the high water table. Constructing roads on suitable, well compacted fill material and providing adequate side ditches and culverts help to protect roads from flood damage and wetness. Providing good surface drainage and the use of a gravel moisture barrier in the subgrade help to reduce damage to roads by frost action. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage.

This soil is in capability unit 11w-1, dryland and irrigated; in the Clayey Overflow range site; and in windbreak suitability group 2S.

**Pt—Pits, Sand and Gravel.** This map unit consists of open excavations, 5 to 30 feet deep, from which sand and gravel have been removed (fig. 13). The individual

areas are irregular in shape and range from 4 to 80 acres in size. The slope is uneven and broken. It ranges from nearly level at the bottom of the pits to almost vertical at the rim. Included in the mapped areas are a few small areas of water.

The material at the bottom of the pits is mainly sand and gravel, but the material varies widely in texture because of the mixing and sorting during excavation. Mounds of spoil overburden are common on the perimeter of the excavations. The bottom and sides of the pits support little or no vegetation.

Most sand and gravel pits are used only as a source of sand and gravel. Most of the gravel is used locally as aggregate for concrete and for surfacing dirt roads. Some pits provide limited habitat for wildlife. Abandoned pits can be reclaimed for agricultural use by shaping the areas, using suitable topdress material from the spoil, and applying fertilizer as needed.

This map unit is in capability unit VIIIs-8, dryland, and in windbreak suitability group 10.

**Rd—Redstoe silt loam, 0 to 2 percent slopes.** This is a moderately deep, nearly level, well drained soil on uplands. The soil formed in silty residuum of soft calcareous siltstone. The areas of the soil range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. A transitional layer is light brownish gray, friable silt loam about 12 inches thick. The underlying material is very pale brown silt loam about 7 inches thick. Soft, chalky siltstone is at a depth of about 27 inches. In places the surface and transitional layers are loam or sandy loam. In some areas bedrock is at a depth of slightly less than 20 or of more than 40 inches. In some areas the dark surface layer is thin, or the surface layer is not dark.

Included with this soil in mapping are small areas of Gavins soils and small areas of siltstone outcrops. Gavins soils and siltstone outcrops generally are in the highest and most convex positions. Gavins soils are less than 20 inches thick and do not have a thick, dark surface layer. Siltstone outcrops are light colored and are not significantly altered by weathering. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is low. Runoff is low. The organic matter content is moderately low. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is used for crops. The rest is used mainly as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. The main limitation is the low available water capacity. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and



Figure 13.—In this gravel pit, the gravel is washed, screened, and stockpiled by size.

legumes helps to maintain or improve the organic matter content and fertility and to increase the water-holding capacity of the soil.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. The main limitations are the low available water capacity and the moderately deep root zone. A sprinkler irrigation system works best on this soil. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to protect the surface. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and fertility and to increase the water-holding capacity.

This soil is suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Pasture and hay can be alternated with other crops as part of a crop rotation. Such cool-season grasses as smooth

brome are suitable, either alone or in a mixture with alfalfa and other legumes or with switchgrass, big bluestem, or other warm-season grasses. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. Nitrogen fertilizer increases the growth and vigor of the grasses. Where a water source is available, irrigation can increase productivity. Weeds can be controlled by spraying with appropriate herbicides.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival and growth rates are fair for adapted species. The main limitations are the low available water capacity, drought, and competition for moisture from weeds and grasses. Supplemental watering may be needed during periods of insufficient rainfall. Plant competition between the rows can be controlled by cultivation with conventional equipment. Plant competition in the rows



can be controlled by careful use of appropriate herbicides or by hoeing by hand.

Mounding or raising a septic tank absorption field with suitable fill material increases the filtering capacity of the soil. This soil generally is suited to use as sites for dwellings without basements. The soft bedrock generally can be easily excavated for construction of dwellings with basements or buildings that have deep foundations. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units IIs-5, dryland, and IIs-7, irrigated; in the Limy Upland range site; and in windbreak suitability group 6R.

#### **RdC—Redstoe silt loam, 2 to 6 percent slopes.**

This is a moderately deep, gently sloping, well drained soil on uplands. The soil formed in silty residuum of soft calcareous siltstone. The areas of this soil range from 5 to 700 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is also very dark grayish brown, friable silt loam; it is about 4 inches thick. A transitional layer is grayish brown, friable silt loam about 6 inches thick. The underlying material is very pale brown and white silt loam about 11 inches thick. Soft, chalky siltstone is at a depth of about 27 inches. The soil is calcareous throughout. In some small areas the surface and transitional layers are loam or sandy loam. In some small areas bedrock is at a depth of slightly less than 20 inches or of more than 40 inches. In some small areas the dark surface layer is thin, or the surface layer is not dark.

Included with this soil in mapping are small areas of Gavins soils and small areas of siltstone outcrops. Gavins soils are in the most convex and generally the highest positions on the landscape. Gavins soils are shallow and do not have a thick, dark surface layer. Siltstone outcrops are in the highest, most convex positions. They are light colored and are not significantly altered by weathering. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is low. Runoff is moderate. The organic matter content is moderately low. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is dry-farmed. The rest is used mainly as pasture, but some is used as rangeland.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Limitations are the low available water capacity and the moderately deep root zone. Conservation tillage, such as no-till, chiseling, and disking, which keep all or part of the crop residue on the surface, helps to prevent

water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler system works best on this soil. Water erosion is a hazard. Limitations are the low available water capacity and the moderately deep root zone. Conservation tillage, such as no-till, chiseling, and disking, which keeps all or part of the crop residue on the surface, helps to prevent water erosion and to conserve moisture. Conservation practices, such as grassed waterways, terraces, and contour farming, help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. To minimize runoff and water erosion on this gently sloping soil, irrigation water must be applied at a rate that does not exceed the soil's moderate intake rate, as well as in sufficient quantity to serve the needs of the crop.

This soil is suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing by livestock or improper haying methods reduce productivity, damage the protective cover, and reduce plant vigor. As a result, after heavy rains, small gullies and rills are common. Management practices, such as rotation grazing and fertilization, are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the range is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the soil; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival rate and growth are fair for adapted species. The limitations are drought, the low available water capacity, competition for moisture from weeds and

grasses, and excess amount of carbonates. Irrigation can provide supplemental moisture when needed. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition between the rows can be controlled by cultivation with conventional equipment. Plant competition in the rows can be controlled by careful use of appropriate herbicides or by hoeing by hand. Only adapted species should be selected.

Mounding or raising a septic tank absorption field with suitable fill material increases the filtering capacity of the soil. This soil generally is suited to use as sites for dwellings without basements. The soft bedrock generally can be easily excavated for construction of dwellings with basements or buildings that have deep foundations. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

This soil is in capability units IIIe-1, dryland, and IIIe-7, irrigated; in the Limy Upland range site; and in windbreak suitability group 6R.

**RdD—Redstoe silt loam, 6 to 11 percent slopes.**

This is a moderately deep, strongly sloping, well drained soil on uplands. The soil formed in silty residuum of soft calcareous siltstone. The areas of this soil range from 5 to 110 acres in size.

Typically, the surface layer is dark gray, friable silt loam about 10 inches thick. A transitional layer is pale brown, friable silt loam about 4 inches thick. White residuum that is very similar to the underlying material makes up as much as 50 percent of the volume of the transitional layer. The underlying material is very pale brown, friable silt loam about 10 inches thick. Soft, chalky siltstone is at a depth of about 24 inches. The soil is calcareous throughout. In some small areas the surface and transitional layers are loam or sandy loam. In some small areas bedrock is at a depth of slightly less than 20 inches or of more than 40 inches. In some small areas the dark surface layer is thin, or the surface layer is not so dark.

Included with this soil in mapping are small areas of Boyd and Gavins soils and siltstone outcrops. The included soils and the siltstone outcrops are in the highest, steepest, and most convex positions. Boyd soils formed in clayey residuum of shale and have much more clay throughout the profile than the Redstoe soil. Gavins soils are shallow and do not have a thick, dark surface layer. Siltstone outcrops are light colored and are not significantly altered by weathering. The included soils make up about 10 percent of the map unit.

Permeability is moderate. The available water capacity is low. Runoff is moderate. The organic matter content is moderately low. Tilth is good, and the soil is easily tilled within a fairly wide range of moisture content. The water intake rate is moderate.

Most of the acreage of this soil is used as pasture and rangeland. Some areas are farmed.

Under dryland management, this soil is poorly suited to corn, soybeans, alfalfa, and oats. Water erosion is the main hazard. Limitations are the low available water capacity and the moderately deep root zone. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is poorly suited to corn, soybeans, and alfalfa. Water erosion is the main hazard. Limitations are the low available water capacity and the moderately deep root zone. A sprinkler system works best on this soil. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to protect the surface. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water. To minimize runoff and water erosion on this strongly sloping soil, irrigation water must be applied at a rate that does not exceed the soil's moderate intake rate, as well as in sufficient quantity to serve the needs of the crop.

This soil is suited to introduced and domesticated grasses for pasture. This use is effective in controlling water erosion. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Overgrazing by livestock or improper haying methods reduce productivity, damage the protective cover, and cause poor plant vigor. As a result, small gullies and rills can form after heavy rains. Such practices as rotation grazing and fertilization are needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling water erosion. The natural plant community consists mainly of tall and mid grasses dominated by big bluestem, little bluestem, switchgrass, and sideoats grama. If the range is overgrazed, big bluestem and little bluestem decrease in abundance and sideoats grama, blue grama, tall dropseed, western wheatgrass, and numerous perennial broadleaf weeds increase. Also, woody plants may migrate to or invade the soil; these include bur oak, eastern redcedar, buckbrush, snowberry, and sumac. Brush management and prescribed burning may be needed to control the woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival rate and growth are fair for adapted species.



The limitations are drought, the low available water capacity, competition for moisture from weeds and grasses, and excess amount of carbonates. Irrigation can supplement moisture if needed. Tillage and chemical methods are effective in preparing a favorable site for planting. Plant competition between the rows can be controlled by conventional equipment. Plant competition in the rows can be controlled by careful use of appropriate herbicides or by hoeing by hand. Only adapted species should be selected.

This soil generally is not suited to use as septic tank absorption fields. An alternate site should be considered. Buildings should be designed to accommodate the slope, or the soil can be graded. The soft bedrock generally can be easily excavated for construction of dwellings with basements or buildings that have deep foundations. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered with coarse base material.

This soil is in capability units IVe-1, dryland, and IVe-7, irrigated; in the Limy Upland range site; and in windbreak suitability group 6R.

**SbD—Sarpy fine sand, 3 to 11 percent slopes.** This is a deep, gently sloping to rolling, excessively drained soil on bottom lands. The soil formed in sandy alluvium that has been reworked by the wind. The areas of this soil range from 5 to 175 acres in size.

Typically, the surface layer is dark grayish brown, very friable fine sand about 6 inches thick. The underlying material is fine sand that is grayish brown over pale brown over very pale brown to a depth of more than 60 inches. The soil is calcareous throughout. In some areas the surface layer is coarser or finer in texture.

Included with this soil in mapping are small areas, in the lowest positions, of soils that are poorly drained. The included areas make up about 5 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is slow. The organic matter content is low. Tilth is good. The water intake rate is very high.

Most of the acreage of this soil is used as rangeland or wildlife habitat, but some is farmed, both dryland and irrigated. A few areas are used as pastureland.

This soil is not suited to dryland cultivated crops because of soil blowing and the low available water capacity.

Under irrigation, this soil is poorly suited to corn and soybeans. A sprinkler system works best on this soil. The main limitation is droughtiness caused by the low available water capacity. Soil blowing is a hazard. Conservation tillage, which keeps the soil covered with residue most of the time, helps to conserve moisture. Frequent, light applications of water are needed for passable yields because the available water capacity is low.

This soil is suited to use as rangeland. This use is effective in controlling soil blowing. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, sand lovegrass, switchgrass, and needleandthread. If the range is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, switchgrass, and sand lovegrass decrease in abundance and needleandthread, prairie sandreed, blue grama, sand dropseed, and western ragweed increase. If overgrazing continues for many years, the plant cover becomes sparse and the sand is subject to very active wind erosion.

This soil is poorly suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity and damage the protective cover; as a result, soil blowing becomes a severe hazard. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve the highest production of forage. If the grasses are hayed, timely mowing helps to maintain optimum productivity.

This soil can be used for trees and shrubs in windbreaks and plantings for recreation use and for wildlife; nevertheless, it provides a poor site for trees and shrubs. The survival rate and growth of adapted species are fair. Insufficient moisture is the main limitation; competition for moisture from weeds and grasses aggravates the limitation. Irrigation can provide moisture for establishment and survival of plantings. Plant competition can be controlled by site preparation prior to planting and by timely mowing of sod between the rows. Plant competition in the rows can be controlled by careful use of appropriate herbicides. Areas in the rows or near small trees can be hoed or rototilled.

This soil readily absorbs the effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. The soil generally is suited to use as sites for buildings. Buildings should be designed to accommodate the slope, or the soil can be graded. This soil generally is suited to local roads and streets.

This soil is in capability units VIIs-7, dryland, and IVe-12, irrigated; in the Sands range site; and in windbreak suitability group 7.

**ScB—Sarpy loamy fine sand, 0 to 3 percent slopes.** This is a deep, nearly level and very gently sloping, excessively drained soil on bottom lands. It is subject to rare flooding. The soil formed in sandy alluvium. The areas of the soil range from 5 to 350 acres in size.

Typically, the surface layer is dark grayish brown, very friable loamy fine sand about 8 inches thick. The underlying material is calcareous and is grayish brown, pale brown, and light gray fine sand to a depth of more

than 60 inches. In some areas the surface layer is silt loam or silty clay loam. In some areas the underlying material is stratified with fine textured material.

Included with this soil in mapping are small areas of Grable soils. Grable soils are in similar or slightly lower positions on the landscape but are silty in the upper part of their profile. The included soils make up about 10 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is slow. The organic matter content is low. Tilth is good, and the soil is easily tilled within a wide range of moisture content. The water intake rate is very high.

Most of the acreage of this soil is farmed. Almost half is irrigated by sprinklers. A small amount is used as pasture or rangeland or for wildlife habitat.

Under dryland management, this soil is poorly suited to corn, soybeans, alfalfa, and oats. The main limitation is the low available water capacity. This soil does not supply sufficient moisture during periods of maximum water requirement. Soil blowing is a hazard. Conservation tillage, such as chiseling and disking, which keeps all or part of the crop residue on the surface, helps to protect the surface. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and fertility and to increase the water-holding capacity of the soil.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on this soil. The critical limitation is the low water-holding capacity. Frequent, light applications of water are necessary for optimum efficiency of irrigation. Soil blowing is a hazard. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and fertility and to increase the available water capacity.

This soil is poorly suited to introduced or domesticated grasses for pasture. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve the highest production of forage. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This soil is suited to rangeland, and this use is effective in controlling soil blowing. The natural plant community consists mainly of mid and tall grasses dominated by little bluestem, sand bluestem, prairie sandreed, switchgrass, and needleandthread. If the range is overgrazed, the site may be dominated by blue grama, hairy grama, sand dropseed, prairie sandreed, Scribner panicum, and numerous annual and perennial

weeds. Brush management may be needed to control woody plants.

This soil is suited to trees and shrubs in windbreaks and to plantings for wildlife and for recreation use. The survival and growth rates of adapted species are fair. Lack of moisture and competition for moisture from weeds and grasses are the main limitations. Irrigation can supplement moisture during periods of low rainfall. Plant competition can be controlled by site preparation through tillage or chemical methods prior to planting and by timely cultivation with conventional equipment. Appropriate herbicides can be applied in the rows, or hoeing or rototilling can be used.

The hazard of rare flooding is a limitation to the use of this soil for sanitary facilities and buildings. This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. Constructing buildings on elevated, well compacted fill material helps to protect buildings from flood damage. Constructing roads on suitable, well compacted fill material above flood level and providing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units IVs-7, dryland, and IIIs-11, irrigated; in the Sandy Lowland range site; and in windbreak suitability group 5.

**Sh—Shell silt loam, 0 to 2 percent slopes.** This is a deep, nearly level, well drained soil on bottom lands. It is subject to occasional flooding. The soil formed in silty alluvium. The areas of this soil range from 10 to 2,340 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is about 25 inches thick. It is dark grayish brown, friable silty clay loam in the upper part and dark gray, friable silt loam in the lower part. The underlying material is silty clay loam to a depth of more than 60 inches. It is grayish brown in the upper part and dark grayish brown in the lower part. In some areas calcium carbonates are at a depth of less than 48 inches. In some areas the soil does not have a mollic epipedon and is stratified in the surface layer.

Included with this soil in mapping are small areas of Alcester soils adjacent to sloping uplands and small areas of Hord soils in the highest positions on the landscape. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is high. Runoff is slow. The organic matter content is moderate. Tilth is good. The water intake rate is moderate.

Most of the acreage of this soil is used for crops. About half is irrigated, and half is dry-farmed. Some areas are used as pasture.

Under dryland management, this soil is suited to corn, soybeans, alfalfa, and oats. Flooding is the main hazard, but flood damage to crops is seldom severe. Flooding can be controlled by retaining precipitation on upland soils. Terraces on upland soils, diversions, and conservation tillage help to retain precipitation and to reduce runoff. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, this soil is suited to corn, soybeans, and alfalfa. Both gravity and sprinkler irrigation systems work well on this soil. In some places land leveling may be required for a gravity system to achieve uniform distribution of water. Flooding is the main hazard, but flood damage to crops is seldom severe. Flooding can be controlled by retaining precipitation on upland soils. Conservation tillage, such as no-till, which keeps all or part of the crop residue on the surface, returning crop residue to the soil, growing green manure crops, applying feedlot manure to the soil, and including grasses and legumes in the cropping system help to maintain or to improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

This soil is suited to introduced or domesticated grasses for pasture. Pasture and hay can be alternated with other crops as part of a crop rotation. The most common grass is smooth brome. Sediment deposited by floodwaters may partly cover the grasses and reduce their vigor and growth. Overgrazing or improper haying methods reduce productivity and damage the protective cover. Separate pastures of cool- and warm-season grasses can provide a long season of grazing. Rotation grazing and proper stocking rates help to maintain the grasses in good condition. Irrigation water can be applied to increase productivity. Weeds can be controlled by spraying with appropriate herbicides.

This soil is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival rate of adapted species is good. Competition for moisture from weeds and grasses is the major limitation. Plant competition can be eliminated by site preparation prior to planting and by timely cultivation with conventional equipment between the rows. Hand hoeing, rototilling, and appropriate herbicides in the rows can also be used.

This soil is not suited to use as septic tank absorption fields and building sites because of flooding. An alternate site should be considered. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material. Constructing roads on suitable, well compacted fill material above flood level

and providing adequate side ditches and culverts help to protect roads from flood damage.

This soil is in capability units 11w-3, dryland, and 11w-6, irrigated; in the Silty Lowland range site; and in woodland suitability group 1.

**StF—Simeon-Talmo-Ortello complex, 9 to 30 percent slopes.** This complex consists of strongly sloping to steep soils on uplands. Simeon soils are excessively drained and deep. Talmo soils are excessively drained and shallow over sand and gravel. Ortello soils are well drained and deep. Simeon soils make up about 40 percent of the complex, Talmo soils make up about 25 percent, Ortello soils make up about 20 percent, and the included soils make up about 15 percent. Generally, Simeon and Ortello soils are on the concave middle and lower parts of side slopes, and Talmo soils are on convex upper side slopes and on ridgetops. The soils making up the complex are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 5 to 140 acres in size.

Typically, the surface layer of the Simeon soil is very dark grayish brown, very friable sandy loam about 9 inches thick. A transitional layer is dark grayish brown, loose coarse sand about 10 inches thick. The underlying material is very pale brown and light gray sand to a depth of more than 60 inches. In some places, some of the sand in the underlying material is of limestone origin.

Typically, the surface layer of the Talmo soil is very dark grayish brown, very friable gravelly coarse sandy loam about 9 inches thick. A transitional layer, to a depth of about 20 inches, is very dark grayish brown, loose gravelly loamy coarse sand in the upper part and brown, loose very gravelly coarse sand in the lower part. The underlying material is yellowish brown gravelly coarse sand over coarse sand over pale brown coarse sand to a depth of more than 60 inches. In some places there are cobbles or boulders on the surface.

Typically, the surface layer of the Ortello soil is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is brown, friable sandy loam about 9 inches thick. The subsoil is friable sandy loam about 20 inches thick. It is pale brown in the upper part and light brownish gray in the lower part. The underlying material is light brownish gray sandy loam to a depth of more than 60 inches.

Included with these soils in mapping are small areas of Blendon and Maskell soils. Blendon soils have dark colors to a depth of more than 20 inches and are in narrow valleys. Maskell soils have dark colors to a depth of more than 20 inches and have more clay throughout. They are on foot slopes and alluvial fans in narrow valleys.

Permeability is rapid in Simeon and Talmo soils and is moderately rapid in the Ortello soil. The available water capacity is very low in Simeon and Talmo soils and is

moderate in the Ortello soil. Runoff is very slow on the Simeon soil and is slow on Talmo and Ortello soils. The organic matter content of the Simeon soil is low, and that of Talmo and Ortello soils is moderately low. Tilth is good.

Almost all of the acreage is used as rangeland. Some areas that are least sloping are farmed, because they form part of a cultivated field.

These soils are not suited to use as cropland because of the low available water capacity and the slope.

These soils are suited to use as rangeland. This use is effective in controlling soil blowing and water erosion. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, sand lovegrass, switchgrass, and needleandthread. If the range is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, prairie sandreed, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue grama, sand dropseed, and western ragweed increase. If overgrazing continues for many years, the less desirable plants increase; these include sand dropseed, sand paspalum, hairy grama, plains pricklypear, and clubmoss.

The soils generally are not suited to trees and shrubs in windbreaks mainly because of the low available water capacity. However, the Ortello soil provides a good site for planting trees and shrubs in windbreaks and for recreation use and wildlife. Drought and competition for moisture from weeds and grasses are the main hazards. Tillage or chemical methods are effective in preparing a favorable site for planting. Supplemental watering may be needed during periods of insufficient rainfall.

The soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. Buildings should be designed to accommodate the slope, or the soil can be graded. Cutting and filling generally are needed to provide a suitable grade for roads. The Ortello soil is subject to frost action. Crowning the road by grading and adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

These soils are in capability unit VIs-4, dryland, and windbreak suitability group 10. The Simeon soil is in the Sands range site, the Talmo soil is in Shallow to Gravel range site, and the Ortello soil is in the Sandy range site.

**TaD—Talmo-Loretto complex, 3 to 9 percent slopes.** This complex consists of gently sloping and strongly sloping soils on uplands. The Talmo soil generally is on the convex upper side slopes and on ridgetops. It is excessively drained and is shallow over gravelly coarse sand. It formed in loamy and sandy material over sand and gravel. The Loretto soil generally is on the concave middle and lower side slopes. It is deep and well drained. It formed in loamy loess over

sandy material. The Talmo soil makes up about 55 percent of the complex, the Loretto soil makes up about 30 percent, and the included soils make up 15 percent. The Talmo and Loretto soils are in areas so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 5 to 50 acres in size.

Typically, the surface layer of the Talmo soil is dark gray, very friable sandy loam about 7 inches thick. A transitional layer is dark grayish brown, loose loamy sand about 11 inches thick. The underlying material is brown gravelly coarse sand over yellowish brown and pale brown coarse sand to a depth of more than 60 inches. In some places there are cobbles and boulders on the surface.

Typically, the surface layer of the Loretto soil is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is grayish brown, friable loam about 9 inches thick. The subsoil is pale brown, friable loam about 25 inches thick. The underlying material is grayish brown gravelly coarse sand to a depth of more than 60 inches. In some places the solum has less clay. In some places sand and gravel are at a depth of less than 40 inches.

Included with these soils in mapping are small areas of Simeon and Thurman soils. Simeon and Thurman soils and the Talmo and Loretto soils are in similar positions on the landscape. Simeon soils contain less gravel than the Talmo soil. Thurman soils are sandy throughout and contain no gravel.

Permeability is rapid in the Talmo soil and moderate over rapid in the Loretto soil. The available water capacity is very low in the Talmo soil and moderate in the Loretto soil. Runoff is slow. The organic matter content is moderately low in the Talmo soil and is moderate in the Loretto soil. Tilth is good.

Most of the acreage of these soils is used as rangeland and pasture. Some is farmed. Most of the areas in crops are irrigated by sprinkler systems.

These soils are not suited to dryland crops, mainly because of the very low available water capacity and the gravel content of the Talmo soil.

Under irrigation, the soils are poorly suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on these soils. The main concern in management is droughtiness. Water erosion and soil blowing are hazards. A cropping system that includes grasses and legumes helps to maintain or improve the organic matter content and the available water capacity and helps to control water erosion and soil blowing. Frequent, light applications of water are needed because the available water capacity of the Talmo soil is very low and that of the Loretto soil is moderate.

These soils are suited to introduced or domesticated grasses for permanent pasture. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity, damage the protective

cover, and cause poor plant vigor. Rotation grazing and fertilization are needed to achieve the highest production of forage. If the grasses are hayed, timely mowing helps to maintain highest productivity. Separate pastures of cool- and warm-season grasses can provide a long grazing season. Irrigation water can be applied by a sprinkler system.

These soils are suited to rangeland. This use is effective in controlling water erosion and soil blowing. The natural plant community consists mainly of tall and mid grasses. The Talmo soil is dominated by sand bluestem, little bluestem, prairie sandreed, needleandthread, blue grama, and sand dropseed. The Loretto soil is dominated by big bluestem, little bluestem, indianguass, sideoats grama, switchgrass, and western wheatgrass. On the Talmo soil, if the range is overgrazed, sand bluestem and prairie sandreed decrease in abundance and blue grama, sand dropseed, and needleandthread increase. If overgrazing continues for many years, the less desirable plants increase; these include sand dropseed, sand paspalum, hairy grama, plains pricklypear, and clubmoss. On the Loretto soil, if the range is overgrazed or is hayed at an improper time, the site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the site; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

The Talmo soil is not suited to trees and shrubs in windbreaks mainly because of the low available water capacity. The Loretto soil provides a good site for trees and shrubs in windbreaks and for plantings for recreation use and for wildlife. Drought and competition for moisture from weeds and grasses are the main hazards. Tillage or chemical methods are effective in preparing a favorable site for planting. Plant competition can be controlled by cultivating between the rows with conventional equipment and by careful use of appropriate herbicides in the rows. Areas in the rows or near small trees can be hoed by hand or rototilled. Supplemental watering may be needed during periods of insufficient rainfall.

The Talmo soil and the underlying material of the Loretto soil readily absorb the effluent from a septic tank absorption field but do not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. The Loretto soil generally is suited to septic tank absorption fields. On both soils buildings should be designed to accommodate the slope, or the soils can be graded. The Talmo soil generally is suited to roads. The Loretto soil has low strength. Roads need to be constructed so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

These soils are in capability units VIs-4, dryland, and IVs-14, irrigated. The Talmo soil is in the Shallow to Gravel range site and in windbreak suitability group 10. The Loretto soil is in the Silty range site and in windbreak suitability group 3.

**ThC—Thurman-Loretto complex, 2 to 6 percent slopes.** This complex consists of deep, gently sloping soils on uplands. The Thurman soil is somewhat excessively drained. It formed in sandy eolian material and outwash deposits. The Loretto soil is well drained. It formed in loamy loess over sand. The Thurman soil makes up about 55 percent of the complex, the Loretto soil makes up about 35 percent, and the included soils make up about 10 percent. The Thurman and Loretto soils are in areas that are so intricately mixed that it was not practical to map the soils separately. The mapped areas range from 5 to 70 acres in size.

Typically, the surface layer of the Thurman soil is very dark grayish brown, friable loamy sand about 8 inches thick. The subsurface layer is also very dark grayish brown, friable loamy sand; it is about 7 inches thick. A transitional layer is brown, friable loamy sand about 4 inches thick. The underlying material extends to a depth of more than 60 inches. It is brown sand in the upper part, light yellowish brown sand in the middle part, and very pale brown fine sand in the lower part. In some small areas the surface layer is sandy loam, fine sand, or loamy fine sand. In some areas calcium carbonates are at a depth as shallow as 15 inches. In some small areas the dark color of the surface layer is dominant to a depth of more than 20 inches.

Typically, the surface layer of the Loretto soil is dark grayish brown, friable loam about 7 inches thick. The subsurface layer is also dark grayish brown, friable loam; it is about 5 inches thick. The subsoil is brown, friable loam about 31 inches thick. The underlying material is pale brown sand to a depth of more than 60 inches. In some areas the surface layer is sandy loam.

Included with these soils in mapping are small areas of Ortello soils. Ortello soils and the Thurman and Loretto soils are in similar positions on the landscape. Ortello soils are in sandy areas near loess uplands. They have less sand and more clay throughout than the Thurman soil, but they have less clay than the Loretto soil in the upper part of the profile.

Permeability is rapid in the Thurman soil and moderate over rapid in the Loretto soil. The available water capacity is low in the Thurman soil (fig. 14) and moderate in the Loretto soil. Runoff is slow. The organic matter content is moderately low in the Thurman soil and moderate in the Loretto soil. Tilth is good. The water intake rate is very high.

Most of the acreage of these soils is dry-farmed, and some is irrigated. The rest is used as pasture and rangeland.





**Figure 14.—Curled leaves of corn under stress because of insufficient soil moisture. Moisture stress affects plants most quickly and most severely on such soils as the Thurman soil in Thurman-Loretto complex, 2 to 6 percent slopes, which has a low available water capacity.**

Under dryland management, these soils are suited to corn, soybeans, alfalfa, and oats. Soil blowing and water erosion are the main hazards. The low or moderate available water capacity is the main limitation. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to control soil blowing and water erosion and to maintain or improve the organic matter content, fertility, and tilth.

Under irrigation, the soils are suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on these soils. Soil blowing and water erosion are the main hazards. The low and moderate available water capacity must be considered in management (fig. 14). Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, helps to protect the surface. A cropping system that includes grasses and legumes helps to control soil blowing and water erosion and to maintain or improve the organic matter content, fertility, and tilth. Careful application of water helps to reduce water erosion and to

prevent the loss of soil productivity and crop damage. Light, frequent applications of water are needed.

This map unit is suited to introduced or domesticated grasses for pasture. This use is effective in controlling wind and water erosion. The most common grass is smooth brome. Pasture and hay can be alternated with other crops as part of a crop rotation. Overgrazing or improper haying methods reduce productivity, damage the protective cover, and impair the plant vigor. As a result, small gullies and rills are common after heavy rains. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve highest forage production. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

This map unit is suited to use as rangeland. This use is effective in controlling wind and water erosion. The natural plant community consists mainly of tall and mid grasses. On the Thurman soil, it is dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the range is overgrazed or is

hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and needleandthread, prairie sandreed, blue grama, purple lovegrass, sand dropseed, and western ragweed increase. On the Loretto soil, the plant cover is dominantly big bluestem, little bluestem, indiangrass, sideoats grama, switchgrass, and western wheatgrass. If the range is overgrazed or is hayed at an improper time, the site may be dominated by blue grama, sideoats grama, tall dropseed, Kentucky bluegrass, Scribner panicum, needleandthread, and numerous perennial broadleaf weeds. Also, woody plants may migrate to or invade the site; these include buckbrush, snowberry, sumac, and roses. Brush management and prescribed burning may be needed to control the woody plants.

This map unit is suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. Competition for moisture from weeds and grasses is the major hazard. Irrigation can provide supplemental moisture during periods of low rainfall. Plant competition can be controlled by site preparation prior to planting and by timely cultivation between the tree rows with conventional equipment. Plant competition in the tree rows can be controlled by hand hoeing, rototilling, and use of appropriate herbicides.

The Thurman soil readily absorbs effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. The Loretto soil generally is suited to use as septic tank absorption fields. The Thurman and Loretto soils generally are suited to use as building sites. However, buildings should be designed to accommodate the slope, or the soil can be graded. The Thurman soil generally is suited to roads. The Loretto soil has low strength. This limitation can be overcome by constructing roads so that the pavement and base material are thick enough to compensate for the low soil strength. Also, the upper part of the soil can be covered or replaced with coarse base material.

These soils are in capability units IIIe-5, dryland, and IIIe-11, irrigated. The Thurman soil is in the Sandy range site and in windbreak suitability group 5. The Loretto soil is in the Silty range site and in windbreak suitability group 3.

**ToD—Thurman-Ortello complex, 6 to 11 percent slopes.** This complex consists of deep, strongly sloping soils on uplands. The Thurman soil is somewhat excessively drained and formed in sandy eolian material and outwash deposits. The Ortello soil is well drained and formed in loamy eolian material. The Thurman soil makes up about 70 percent of the complex, the Ortello soil makes up about 20 percent, and the included soils make up about 10 percent. The Thurman and Ortello soils are in areas that are so intricately mixed that it was

not practical to map the soils separately. The mapped areas range from 5 to 300 acres in size.

Typically, the surface layer of the Thurman soil is very dark gray, very friable loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown, very friable loamy sand about 5 inches thick. A transitional layer is brown, very friable sand about 9 inches thick. The underlying material extends to a depth of more than 60 inches. It is sand that is light yellowish brown over very pale brown. In some small areas the dark colors of the surface layer are dominant to a depth of less than 10 inches. In some areas the surface layer is sandy loam. In some areas the texture ranges to coarse sand. In some areas the depth to calcium carbonates is as little as 15 inches.

Typically, the surface layer of the Ortello soil is dark grayish brown, friable sandy loam about 6 inches thick. The subsurface layer is friable sandy loam about 8 inches thick. It is dark grayish brown in the upper part and brown in the lower part. The subsoil is about 24 inches thick. It is friable sandy loam that is brown in the upper part and pale brown in the lower part. The underlying material is pale brown sandy loam to a depth of more than 60 inches. In some places the surface layer is silt loam or loam. In some small areas the underlying material may contain pebbles.

Included with these soils in mapping are small areas of Loretto soils. Loretto soils and the Thurman and Ortello soils are in similar positions on the landscape. Loretto soils have less sand and more clay in the upper part of the profile.

Permeability is rapid in the Thurman soil and moderately rapid in the Ortello soil. The available water capacity is low in the Thurman soil and moderate in the Ortello soil. Runoff is slow. The organic matter content is moderately low. Tilth is good. The water intake rate is very high.

About half of the acreage of the soils is dry-farmed, and some areas are irrigated. The rest is used as pasture and rangeland.

Under dryland management, these soils are poorly suited to corn, soybeans, alfalfa, and oats. Water erosion and soil blowing are the main hazards. The low and moderate available water capacity is the main limitation. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. Practices such as grassed waterways, terraces, and contour farming help to control water erosion. A cropping system that includes grasses and legumes helps to control water erosion and to maintain or improve the organic matter content, fertility, and tilth and to increase the infiltration of water.

Under irrigation, the soils are poorly suited to corn, soybeans, and alfalfa. A sprinkler irrigation system works best on these soils. The main hazards are soil blowing and water erosion, and the main limitation is the low and



moderate available water capacity. Conservation tillage, such as no-till, chiseling, or disking, which keeps all or part of the crop residue on the surface, is needed to protect the surface. A cropping system that includes grasses and legumes helps to control water erosion and soil blowing and to maintain or improve the organic matter content, fertility, and tilth. Careful application of water is needed to control water erosion and to prevent the loss of soil productivity and damage to crops. Light, frequent applications of water are needed.

The soils are suited to introduced or domesticated grasses for pasture. This use is effective in controlling water erosion. The most common grass is smooth brome. Overgrazing or improper haying methods reduce productivity, damage the protective cover, and cause poor plant vigor. As a result, small gullies and rills are common after heavy rains. Pasture and hayland management, such as rotation grazing and fertilization, is needed to achieve the highest production of forage. If the grasses are hayed, timely mowing helps to maintain high productivity. Separate pastures of cool- and warm-season grasses can provide a long season of grazing.

The soils are suited to use as rangeland, and this use is effective in controlling soil blowing and water erosion. The natural plant community consists mainly of tall and mid grasses dominated by sand bluestem, little bluestem, prairie sandreed, switchgrass, and needleandthread. If the range is overgrazed or is hayed at an improper time, sand bluestem, little bluestem, and switchgrass decrease in abundance and

needleandthread, prairie sandreed, blue grama, purple lovegrass, sand dropseed, and western ragweed increase.

The soils are suited to trees and shrubs in windbreaks and to plantings for recreation use and for wildlife. The survival and growth rates of adapted species are fair. The main limitations are wind erosion, competition for moisture from weeds and grasses, and insufficient moisture. Soil blowing can be controlled by maintaining strips of sod or an annual cover crop between the rows. Sod between the rows should be mowed to help maintain a dense cover. Plant competition in the tree rows generally should be controlled only by cultivation. Areas near the trees can be hoed by hand. Irrigation can provide supplemental water during periods of insufficient moisture.

These soils readily absorb effluent from a septic tank absorption field, but they do not adequately filter the effluent. The poor filtering capability may result in pollution of the underground water table. Buildings should be designed to accommodate the slope, or the soils can be graded. Cutting and filling generally are needed to provide a suitable grade for roads. Crowning the road by grading and constructing adequate side ditches help to provide good surface drainage; thus, damage to roads by frost action is reduced or prevented.

These soils are in capability units IVe-5, dryland, and IVe-11, irrigated, and in the Sandy range site. The Thurman soil is in windbreak suitability group 7, and the Ortello soil is in windbreak suitability group 5.

# Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Cedar County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not subject to frequent flooding during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 200,266 acres, or nearly 42 percent of the county, is prime farmland. Areas of prime farmland are scattered throughout the county.

A recent trend in land use in some parts of the county has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Cedar County. On some soils included in the list, appropriate measures have been applied to overcome a hazard of limitation, such as flooding, wetness, or droughtiness. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

AcC	Alcester silt loam, 2 to 6 percent slopes
Ao	Aowa silt loam, 0 to 2 percent slopes
Bk	Blake silty clay loam, 0 to 2 percent slopes
BmC	Blendon fine sandy loam, 2 to 6 percent slopes
Bn	Blendon loam, 0 to 2 percent slopes
Ce	Colo silty clay loam, 0 to 2 percent slopes (where drained)
CnC2	Crofton-Nora complex, 2 to 6 percent slopes, eroded
EI	Eltree silt loam, 0 to 2 percent slopes
EIC	Eltree silt loam, 2 to 6 percent slopes
Gr	Grable silt loam, 0 to 2 percent slopes
Hn	Hobbs silt loam, 0 to 2 percent slopes
Hr	Hord silt loam, 0 to 2 percent slopes
Hs	Hord silt loam, bedrock substratum, 0 to 2 percent slopes
Lb	Lamo silty clay loam, 0 to 2 percent slopes (where drained)
LoC	Loretto loam, sand substratum, 2 to 6 percent slopes
Ma	Maskell loam, 0 to 2 percent slopes
MaC	Maskell loam, 2 to 6 percent slopes
Mm	Modale silt loam, 0 to 2 percent slopes
Mo	Moody silty clay loam, 0 to 2 percent slopes
MoC2	Moody silty clay loam, 2 to 6 percent slopes, eroded
Nb	Nimbro silt loam, 0 to 2 percent slopes

On	Onawa silty clay, 0 to 2 percent slopes (where drained)	Rd	Redstoe silt loam, 0 to 2 percent slopes
OrC	Ortello sandy loam, 2 to 6 percent slopes	RdC	Redstoe silt loam, 2 to 6 percent slopes
Pe	Percival silty clay, 0 to 2 percent slopes	Sh	Shell silt loam, 0 to 2 percent slopes

# Use and Management of the Soils

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This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and to the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and in windbreaks; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

## Crops and Pasture

William E. Reinsch, conservation agronomist, Soil Conservation Service, helped to prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated

yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service.

About 71 percent of the land in farms is used as cropland and 29 percent as pasture and rangeland. About 18 percent of the cropland is irrigated. The soils in capability classes IIw-4 and IIe-1 have good potential for increased production of food.

## Dryland Management

Good management practices on dry-farmed cropland are those that reduce runoff and the hazard of erosion, conserve moisture, and improve tilth. Many soils in the county are suitable for crop production. In places, however, the hazard of erosion is severe and management practices are needed to reduce erosion.

Terraces, contour farming, grassed waterways, and conservation tillage, which keeps crop residue on the surface, help to reduce water erosion and runoff and to increase intake rates and the moisture available to crops. Crop residue kept on the surface or a protective plant cover reduces sealing and crusting of the soil during and after heavy rains. In winter, the stubble catches drifting snow (fig. 15). The snowmelt then provides additional moisture in spring.

Soil blowing in the county is a hazard on Blendon, Ortello, Sarpy, and Thurman soils. Soil blowing can be controlled by crop residue management, conservation tillage, contour strip cropping, and narrow field windbreaks. The hazard of erosion can be reduced if the more productive, less sloping soils are used for row crops, and the steeper, more erodible soils are used for close-growing crops, such as small grains and alfalfa, or for grasses for hay and pasture. Proper use of the land alone can reduce the erosion hazard in many areas.

In Cedar County insufficient rainfall is a common limitation to crop production. On most soils water and wind erosion are hazards. Conservation cropping systems and other management practices that control erosion should be planned and implemented for the soils in each field.

The sequence of crops grown in a field, in combination with the practices needed for management and



Figure 15.—Corn stubble traps snow in an area of Crofton-Nora complex, 6 to 11 percent slopes, eroded. The snowmelt increases the moisture available for the next crop. Compare the windswept, partly bare hillside at extreme right.

conservation of the soil, is known as a resource management system. Under dryland farming, the resource management system should improve tilth and fertility, maintain a plant cover that protects the soil from erosion, and control weeds, insects, and diseases. On cropland the resource management system varies with the soils. For example, on Thurman-Loretto complex, 2 to 6 percent slopes, a resource management system should include a conservation tillage system of row-crop production. However, on Moody silty clay loam, 6 to 11 percent slopes, eroded, it should include terraces, contour farming, and crop residue management when row crops are grown in the rotation (fig. 16). Such a system will help to control water erosion and to maintain the fertility and tilth of the soil.

On Class IIe soils, such as Moody silty clay loam, 2 to 6 percent slopes, eroded, a resource management system for cultivated fields should protect the soil and control erosion. It should include contour tillage, leaving crop residue on the surface, conservation tillage, and adding fertilizers and manure to the soil. On Class IVe-5 soils, such as Thurman-Ortello complex, 6 to 11 percent slopes, a resource management system should include leaving crop residue on the soil over the winter, contour farming, and a conservation tillage system that leaves

3,000 pounds per acre of corn or sorghum residue or 1,500 pounds of small grain residue on the surface after replanting. These practices help to hold water erosion and soil blowing to an acceptable level.

Tillage is occasionally needed to prepare a seedbed for crops and to control weeds. Excessive tillage, however, breaks down the structure in the surface layer that is necessary for good soil tilth. The cultivation process should be limited to those steps that are indispensable. Conservation tillage, such as no-till, till-planting, disking, or chiseling, is well suited to row crops. Grasses can be established by drilling into a cover of stubble without further seedbed preparation.

Soil tests can be used for cultivated crops or for pasture to determine the need for additional nutrients. Under dryland management, applications of fertilizers should be based on the results of soil tests and on the moisture content of the soil at the time when the fertilizers are applied. If the subsoil is dry or if rainfall is below normal, the amount of phosphorus-nitrogen fertilizer applied should be slightly less than the recommended amount. Nitrogen fertilizer helps nonlegume crops on all soils. Phosphorus and zinc are needed on the more eroded soils and in cut areas after construction of terraces or diversions. Dry-farmed





**Figure 16.**—The newly constructed terraces at center were designed to reduce runoff and control erosion and also to increase the moisture available to crops on these strongly sloping soils. The soils are Moody silty clay loam, 6 to 11 percent slopes, eroded, and Loretto loam, sand substratum, 6 to 11 percent slopes.

cropland requires smaller amounts of fertilizer than irrigated cropland because the plant population generally is lower. Some soils in the county, such as Baltic soils, are poorly drained because of a moderately high water table. Open drainage ditches and underground tile systems can be used to help lower the water table if there are suitable outlets at a lower elevation. If the water table cannot be lowered sufficiently for good crop growth, water-tolerant crops can be grown.

Herbicides can be used to control weeds. It is important that the kind of herbicide and the application rate correspond to soil conditions. The colloidal clay and humus fractions are associated with most of the chemical activity in the soil. Consequently, herbicides are more likely to damage crops on the coarse and moderately coarse soils that are low in colloidal clay and in areas where the organic matter content is moderately

low. On these soils, herbicides need to be applied with care and at a relatively low rate. Keeping field boundaries on the contour helps to ensure greater uniformity of soils in a field, results in more uniform weed control, and lessens the danger of any damage from herbicides.

### **Irrigation Management**

In 1979, 18 percent of the cropland in the county was irrigated, according to the National Resources Inventory. Corn was grown on more than 90 percent of the irrigated cropland, and soybeans and alfalfa were grown on a small acreage. More than 80 percent of the irrigation systems were the sprinkler type.

Irrigation in Cedar County is used mainly to supplement natural rainfall. Either furrow or sprinkler



systems are suited to corn and other row crops. Border, contour ditch, corrugation, or sprinkler systems can be used for alfalfa.

The cropping sequence on soils that are well suited to irrigation consists mainly of row crops. A sequence in which corn is followed by soybeans, alfalfa, and grass helps to control the plant diseases and insects that increase if the same crop is grown year after year. Soil blowing is a hazard on such soils as Thurman-Ortello complex, 6 to 11 percent slopes, if the soils are used for cultivated crops. If the cropland is irrigated, soil blowing can be controlled by leaving standing cornstalks 16 inches tall until the spring crop is planted. Conservation practices, such as conservation tillage, contour farming, and leaving a protective cover of crop residue on the surface after the crop is planted, help to conserve water. They reduce evaporation and runoff, increase the soil's intake of water, and help to control water and wind erosion.

In sprinkler irrigation, water should be applied at a rate that the soil can absorb without runoff. Sprinklers can be used on the more sloping soils as well as on the nearly level soils. Some coarse textured soils, such as Thurman-Loretto complex, 2 to 6 percent slopes, are better suited to sprinkler irrigation if conservation practices are used to control soil blowing. Because the water can be carefully controlled, sprinklers have special uses in conservation, such as establishing grass stands and improving seed germination of most crops. In summer, however, much water is lost through evaporation. Wind drift can cause the water to be unevenly applied. Watering at night, when the wind velocity and the temperature are lowest, reduces evaporation and improves distribution.

Sprinkler systems are of three general kinds. One kind is set up at a location and is removed when a specified amount of water has been applied. A center pivot irrigation system is a moving device that has sprinkler arms rotating on a central pivot. A volume gun is a single large sprinkler that moves constantly while applying water.

The soil holds a limited amount of water, and irrigation water or precipitation is needed at regular intervals to keep the soil moist. The application interval varies according to the crop, the soil, and the amount of moisture in the soil. The water should be applied no faster than the soil can absorb it.

Irrigated sandy soils in Cedar County hold about 1 inch of available water per foot of soil depth. A sandy soil that is 4 feet deep and is planted to a crop that sends its roots to that depth can hold about 4 inches of available water for the crop.

For maximum efficiency, irrigation should be started when about half of the stored water has been used by the plants. For example, if a soil holds 4 inches of available water, irrigation should be started when about 2 inches have been removed by the crop. An irrigation

system should replace water at the rate that will provide a stable water supply for the crop.

Irrigated soils generally produce higher yields than dry-farmed soils. Consequently, more plant nutrients, particularly nitrogen and phosphorus, are removed by harvested crops on irrigated soils. Returning all crop residue to the soil and adding manure and commercial fertilizer to the soil help to maintain the needed plant nutrients. Most grain crops in the county respond to nitrogen fertilizer. Land leveling increases the efficiency of irrigation because the water is more evenly distributed. However, soils that have been leveled, particularly if the topsoil has been removed, may need additions of phosphorus, zinc, and iron. Applications of fertilizer needed for a specific crop should be based on soil tests.

The soils in the county that are suited to irrigation are assigned to an irrigation design group. The design groups are described in the Nebraska Irrigation Guide (17). Arabic numbers indicate the design group to which a soil belongs.

Assistance in planning and designing an irrigation system is available at the local office of the Soil Conservation Service or the county agricultural agent.

### **Pasture and Hayland Management**

The grasses in a pasture or on hayland need to be kept productive. A planned grazing system that meets the needs of the plants and promotes uniform utilization of forage is important for high returns. Most forage plants are a good source of minerals, vitamins, proteins, and other nutrients, and a well managed pasture can provide a balanced ration throughout the growing season.

A mixture of adapted grasses and legumes can be grown on many kinds of soils. Grasses and legumes are compatible with grain crops in a crop rotation and have beneficial soil-building effects. They improve tilth, add organic matter, and reduce erosion. They are an ideal crop for use in a conservation cropping system.

Grasses and legumes that are used for pasture and hayland, either irrigated or nonirrigated, require additional plant nutrients to obtain maximum vigor and growth. The kind and amount of fertilizer needed should be determined by a soil test. In irrigated pastures the most commonly grown grasses are smooth brome and orchardgrass. Other grasses that are adapted to irrigation are intermediate wheatgrass, meadow brome, and creeping foxtail. Legumes that have potential for irrigated or nonirrigated pasture are alfalfa, birdsfoot trefoil, and cicer milkvetch.

Irrigated pasture in the county can produce 750 to 900 pounds of beef per acre under a high level of management. Irrigated pasture is an economic alternative in planning a resource management system for irrigated cropland. Cropland can be converted to irrigated pasture to control erosion by changing land use.



Figure 17.—Dairy cattle grazing smooth brome in a nonirrigated pasture in an area of Crofton-Nora complex, 11 to 15 percent slopes, eroded.

Grasses that have potential in nonirrigated pasture are smooth brome, intermediate wheatgrass, meadow brome, tall fescue, and orchardgrass (fig. 17). Some warm-season native grasses, if seeded as a single species on nonirrigated pastureland, are compatible with cool-season pasture grasses; thus, forage quality during the grazing season is extended. Switchgrass, indiagrass, and big bluestem are warm-season native grasses that can be used in a planned grazing system to provide high quality forage in summer.

#### Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The

land capability classifications under nonirrigated and irrigated conditions are also shown for each unit.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

### Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

*Capability classes*, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

*Capability subclasses* are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-8 or IIle-1.

The capability classification of each map unit is given in the section "Detailed Soil Map Units." It is also shown in table 5 and in the listing of interpretive groups at the end of this survey.

### Rangeland

Peter N. Jensen, range conservationist, Soil Conservation Service, helped to prepare this section.

Rangeland makes up approximately 12 percent of the agricultural land in Cedar County. It is scattered in small tracts throughout the county, but most of the rangeland is in the northern part. The soils that are used for grazing or for native hay are mainly in areas of the Redstoe-Gavins, Betts-Ortello-Talmo, Crofton-Alcester, and Loretto-Thurman-Ortello associations. The average size of livestock farms in Cedar County is about 480 acres.

Raising livestock, mainly cow and calf herds from which the calves are sold as feeders in the fall, is the second largest agricultural enterprise in the county. Generally, the cattle graze the range from late in spring to early in fall. In fall they graze regrowth of native meadows or corn residue on irrigated or nonirrigated cropland. They are fed native hay or alfalfa hay, or both, in winter and early in spring. The forage on rangeland is supplemented with protein in fall and winter. Some rangeland in the county has been overgrazed. Specifically, about 72 percent is producing less than half of its potential in kind or amount of native plants. The

reason for the low production is largely overuse by livestock, caused by overstocking and poor livestock distribution.

The main objective of range management is to maintain the range in good or excellent condition. Range management practices that maintain or improve range condition are economical and are needed on all rangeland that is grazed. Such practices include proper grazing use that leaves adequate plant cover to maintain or improve plant vigor; deferred grazing, or resting key management plants periodically during the carbohydrate storage phase; and a planned grazing system whereby pastures are alternately grazed and rested in a planned sequence. Also, properly locating fences, developing livestock watering facilities, such as wells and stockponds, and moving salt to areas where grazing is desired help to distribute livestock for uniform grazing.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil listed, the soil name, the soil map symbol, the range site, and the potential annual production of vegetation in favorable, normal, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

*Potential annual production* is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

*Dry weight* is the total annual yield per acre reduced to a common percent of air-dry moisture content.

Most of the rangeland in the county is in the Sands, Sandy, Silty, Limy Upland, Savannah, and Shallow Limy range sites. The rest is in the Wet Subirrigated, Subirrigated, Silty Overflow, Clayey Overflow, Silty Lowland, Clayey, Thin Loess, and Shallow to Gravel range sites.

At the end of each map unit description, the soil or soils in that unit are placed in an appropriate range site according to the kind and amount of the vegetation that grows on the soil when the site is in climax condition or is supporting its full natural potential. The range site assigned to each soil is given also in the listing of interpretive groups at the end of this survey. Descriptions and interpretations for each range site in the county are available at the local office of the Soil Conservation Service. Livestock producers who want technical assistance in reseeding cropland, developing a planned grazing system, or implementing other range management or improvement conservation practices can obtain help at the local office of the Soil Conservation Service.

## Native Woodland

Keith A. Ticknor, forester, Soil Conservation Service, helped to prepare this section.

Woodland makes up approximately 7,300 acres, or 1.5 percent of the county. It is along the major streams and their tributaries, in blocks or strips along the Missouri River, in wet upland drainageways, and on steep slopes south of the Missouri River. Some areas of woodland along the Missouri River (fig. 18) and on the slopes south of the river are fairly large.

Along the Missouri River, woodland consists mainly of eastern cottonwood. On the steep slopes south of the river and on other slopes that face north and east, it consists predominantly of bur oak. Associated with the bur oak are green ash, eastern redcedar, American and red elm, hackberry, black walnut, eastern hophornbeam, American basswood, dogwood, gooseberry, and sumac.

Along the major streams and upland drainageways, woodland consists mainly of eastern cottonwood, boxelder, black willow, elms, green ash, Russian mulberry, black walnut, and American plum. Many of the trees, especially black walnut, eastern cottonwood, bur oak, and green ash, have commercial value for wood products. However, very few wooded areas are managed for commercial production. Most areas are privately owned and make up only a small acreage of a farm.

Since 1955, the acreage of woodland in Cedar County has decreased by approximately 40 percent. Most of the decline has come about as woodland has been cleared for cultivation. Many of the areas of cottonwood along the Missouri River have been converted to cropland.

Soils on bottom lands along the rivers and streams and in drainageways have good potential for production of sawtimber, firewood, Christmas trees, and other wood





Figure 18.—The most extensive areas of woodland in Cedar County are on Sarpy and Grable soils on bottom lands of the Missouri River.

products, but most of these soils are used as cropland and are not likely to be converted to production of wood products. Odd areas or small fields that are difficult to farm are good potential sites for woodland.

### Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped to prepare this section.

Most farmsteads in Cedar County have trees around them that have been planted at various times by the landowners since the farmstead was established (fig. 19). Siberian elm is the most common species, especially in the older windbreaks. Some other common

species are eastern redcedar, green ash, boxelder, eastern cottonwood, Russian-olive, lilac, honeylocust, Russian mulberry, and ponderosa pine.

Tree planting around the farmstead is a continuing process. Old trees pass maturity and deteriorate. Some trees are lost because of insects and disease, and others are destroyed by storms. New windbreaks are needed for expanding farmsteads. Many of these farmstead windbreaks could be improved by adding 1 or 2 rows of supplemental plantings. Renovation, including thinning, removal, and replanting, is needed to maintain the value and effectiveness of old windbreaks that have reached maturity and are deteriorating.

Field windbreaks, or shelterbelts, are common in the county, especially southeast of Crofton. Many of these field windbreaks consist of 8 to 10 rows of trees and shrubs. The common species are eastern cottonwood, Siberian elm, honeylocust, Russian-olive, ponderosa pine, green ash, hackberry, and Russian mulberry.

In order for windbreaks to fulfill their intended purpose, the species of trees or shrubs selected must be adapted to the soils in the area. Matching the proper trees with the soil is the first step toward ensuring survival and achieving the maximum rate of growth. Permeability, the available water capacity, and soil fertility greatly affect the rate of growth of trees and shrubs in windbreaks.

Generally, trees and shrubs can be easily established in the county if the basic rules of tree culture are followed. Proper site preparation and controlling plant competition after planting are the major concerns in establishing and managing a windbreak.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various



Figure 19.—A farmstead windbreak, consisting of eastern redcedar, honeylocust, and green ash. The soil is Moody silty clay loam, 2 to 6 percent slopes, eroded.



soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

## Recreation

Robert O. Koerner, biologist, Soil Conservation Service, helped to prepare this section.

The reach of the Missouri River bounding Cedar County is one of the few that remain in a relatively natural state. This reach is a major recreation resource and was incorporated into the National Wild and Scenic Rivers System in November 1978 in the category of recreational rivers. There are many scenic overlooks along the bluffs of the Missouri River, which are intersected by heavily wooded draws.

In a study of the potential for outdoor recreation in Cedar County, 11 kinds of recreation were evaluated and appraised (10).

The recreation enterprises rated as having high potential included vacation cabins, cottages, and homesites; fishing waters; vacation farms and ranches; and natural, scenic, and historic areas. The recreation enterprises rated as having medium potential included camping; picnic and sports areas; golf courses; hunting areas; shooting preserves; and water sports areas. The recreation enterprise rated as having low potential was riding stables.

There are golf courses in Laurel, Randolph, and Hartington. Municipal picnic areas in the county include 5 acres in Hartington, 30 acres in Coleridge, and 1 acre in Randolph. A church camp in Belden provides a barracks-type shelter with live-in accommodations.

A 100-acre area below Gavins Point Dam (fig. 20) in the northwestern part of the county provides fishing in summer and winter, picnicking, and boating. The area is maintained by the State Game and Parks Commission.

Wildlife species in the county include ring-necked pheasant, bobwhite quail, cottontail rabbit, Hungarian partridge, white-tailed deer, eagles, hawks, and wild turkey. Regular hunting seasons for game species are set by the Nebraska Game and Parks Commission.

Fishing in the Missouri River is good to excellent for catfish, northern pike, paddlefish, walleye, and sauger. Fishing for bass, bluegill, and catfish in farm ponds is also available with the owner's permission.

Technical assistance for designing installations to improve habitat for wildlife, as well as facilities for recreation, is available at the field office of the Soil Conservation Service in Hartington.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and by the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

*Camp areas* require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

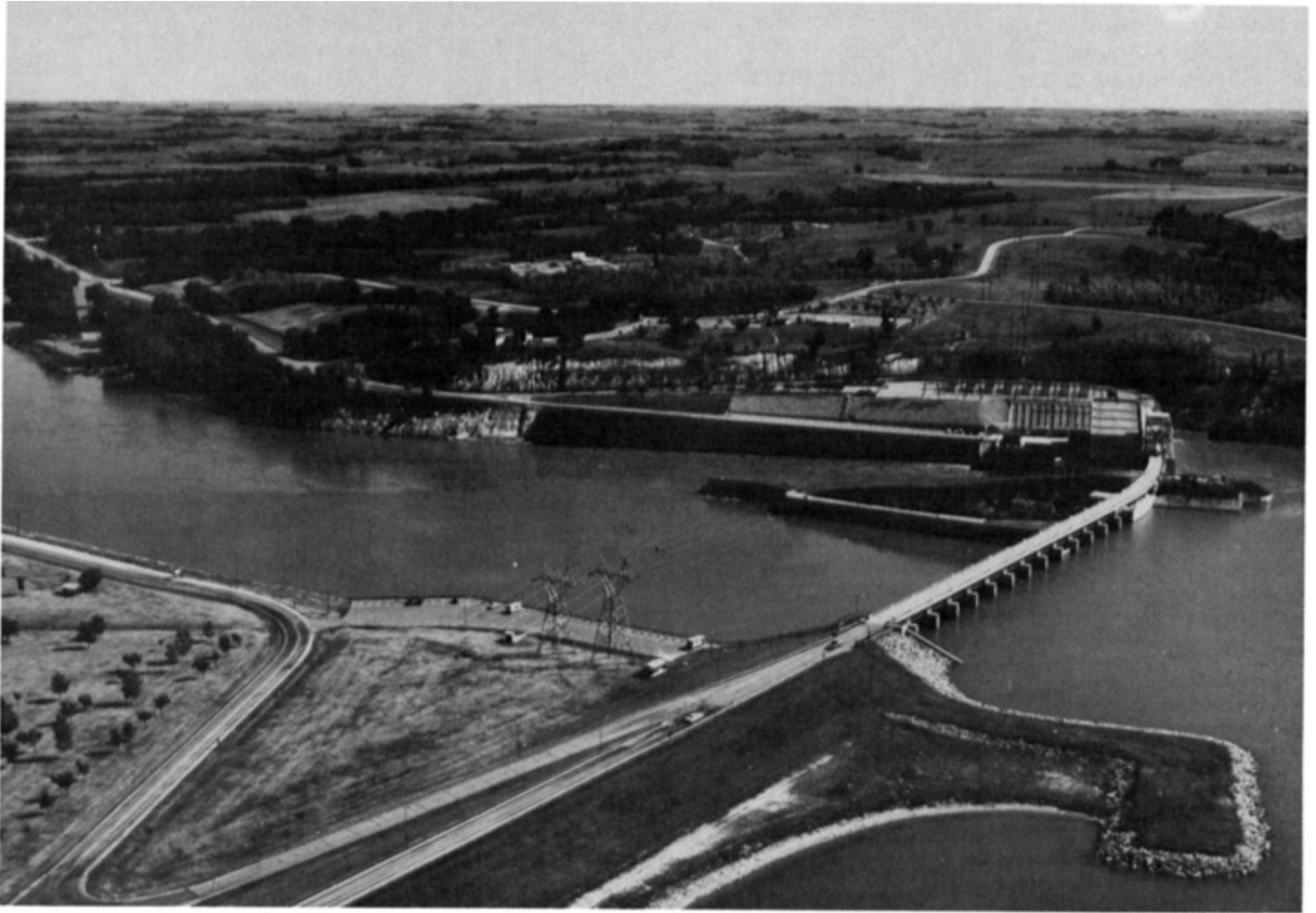


Figure 20.—Gavins Point Dam on the Missouri River. The view is southward into Cedar County. The recreation area downstream from the dam attracts nearly a million visitors every year.

*Paths and trails* for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

*Golf fairways* are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

## Wildlife Habitat

Robert O. Koerner, biologist, Soil Conservation Service, helped to prepare this section.

Wildlife habitat in Cedar County varies with the soil, topography, slope, and drainage pattern. In the northern part of the county, the Missouri River, the adjacent flood plain, and the river breaks provide diverse cover types for white-tailed deer, wild turkey, ring-necked pheasant, bobwhite quail, Hungarian partridge, eastern fox squirrel, cottontail, jackrabbit, raccoon, opossum, mink, muskrat, beaver, songbirds, hawks, owls, and eagles.

The plant species in the county include grasses, such as big and little bluestem, switchgrass, indiagrass, sideoats and blue grama, and buffalograss, and wild forbs and legumes; trees and shrubs, such as

cottonwood, willow, green ash, hackberry, Russian mulberry, boxelder, black walnut, Russian-olive, honeysuckle, sumac, dogwood, native rose, chokecherry, and buckbrush; and vines, such as wild grape, bittersweet, greenbrier, poison ivy, Virginia creeper, and wild cucumber.

The major drainages flowing into the Missouri River include Beaver Creek, Antelope Creek, Bow Creek and its tributaries, and Ames Creek. The drainages provide riparian habitat for wildlife (fig. 21). They also provide

travel lanes for wildlife to move from the bottom lands along the Missouri River to upland grainfields and grassland.

On the uplands above the Missouri River, native rangeland, pastureland, and cropland are favorable cover types for openland wildlife species, such as bobwhite quail, ring-necked pheasant, and Hungarian partridge.

In the southern half of the county, the soils are used mainly as cropland, and corn, soybeans, and alfalfa are

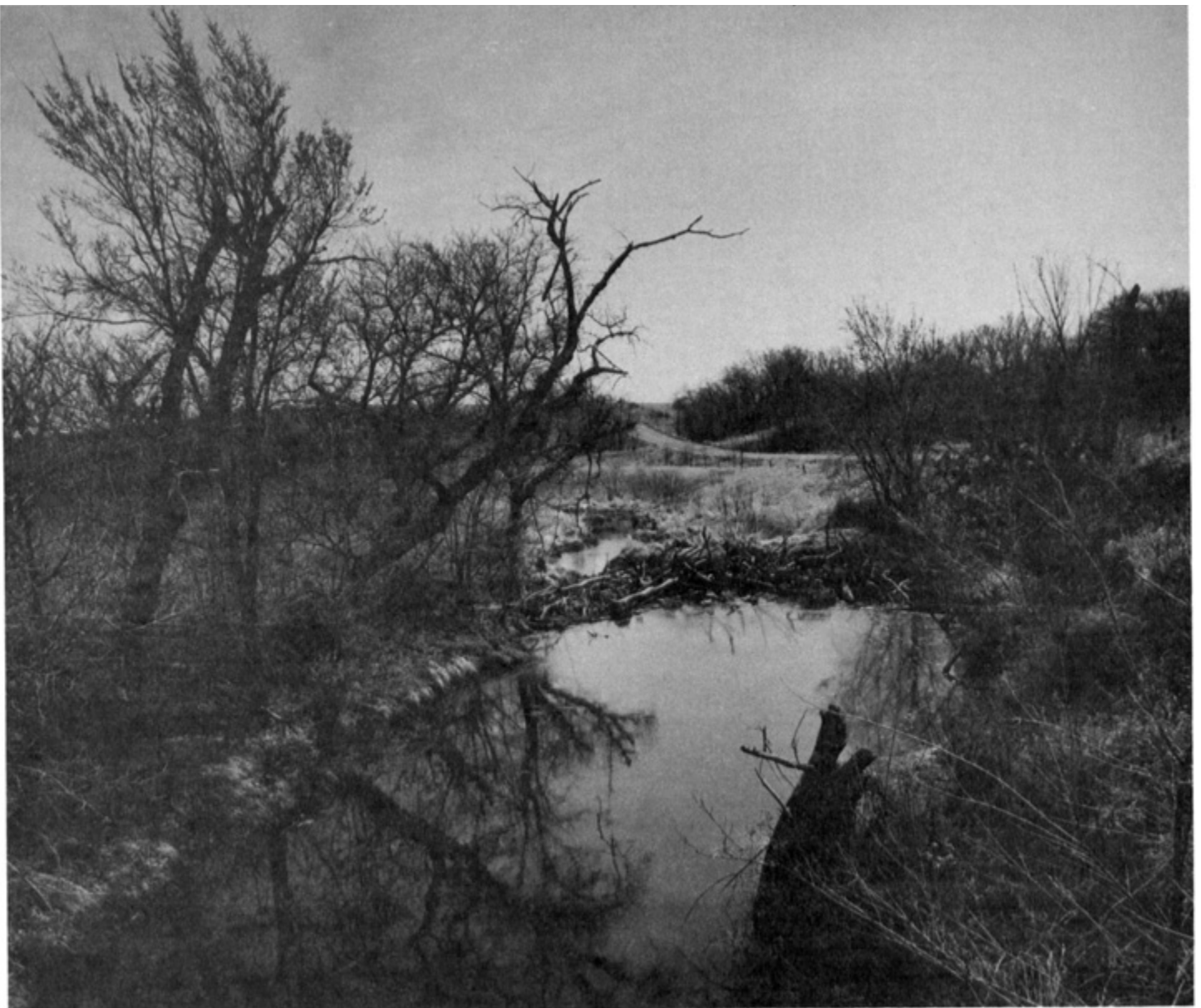


Figure 21.—Beaver dams are common in the northern part of the county, where strips of woodland extend along perennial creeks.



the major crops. In winter, wildlife habitat is limited, and wildlife populations are lower.

Mourning doves are common throughout the county. There are feeding areas and nesting sites for waterfowl along the Missouri River and in wetland areas on bottom lands.

Suitable habitat for wildlife exists in the wooded drainages and fence rows and along roadside ditches. Winter cover for wildlife can be greatly improved by providing more cover, such as farmstead shelterbelts, and by leaving tall grain stubble or cornstalks standing over winter. Wooded and herbaceous cover along waterways should be preserved.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

*Grain and seed crops* are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, smooth brome grass, clover, and alfalfa.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western ragweed, wheatgrass, and blue grama.

*Hardwood trees* and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, mulberry, chokecherry, green ash, honeylocust, apple, hawthorn, eastern cottonwood, and gooseberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are sumac, autumn-olive, and native plum.

*Coniferous plants* furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

*Shrubs* are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are native plum, lilac, snowberry, and sumac.

*Wetland plants* are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, prairie cordgrass, rushes, sedges, and reedgrass.

*Shallow water areas* have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

*Habitat for openland wildlife* consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, Hungarian partridge, pheasant, meadowlark, field sparrow, cottontail, skunk, badger, coyote, and red fox.

*Habitat for woodland wildlife* consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, owls, thrushes, woodpeckers, squirrels, red fox, raccoon, and deer.

*Habitat for wetland wildlife* consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

*Habitat for rangeland wildlife* consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include badger, ground squirrels, deer, grouse, meadowlark, and lark bunting.

## Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

*Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.*

*The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations must be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to

bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

## Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented layer, or a very firm dense layer; stone content; soil texture; and slope. The time of the

year that excavations can be made is affected by the depth to a seasonal high water table and by the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and by the depth to the water table.

*Dwellings and small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost-action potential, and depth to a high water table affect the traffic-supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

### Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant

increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

*Septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

*Sewage lagoons* are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive



or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

*Daily cover for landfill* is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plant growth. Material from the surface layer, therefore, should be stockpiled for use as the final cover.

### Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good*, *fair*, or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of

the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

*Roadfill* is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

*Sand and gravel* are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain

sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

## Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in

construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*Drainage* is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

*Irrigation* is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected

by the depth of the root zone, the amount of salts or sodium, and soil reaction.

*Terraces and diversions* are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

*Grassed waterways* are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

# Soil Properties

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Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

## Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

*Classification* of the soils is determined according to the Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

## Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

*Moist bulk density* is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

*Permeability* refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

*Available water capacity* refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of

plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

*Soil reaction* is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

*Salinity* is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69.

The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity,

infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;



November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

*Depth to bedrock* is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

*Potential frost action* is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is

not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

## Physical and Chemical Analyses of Selected Soils

Samples from soil profiles were collected for physical and chemical analysis by the Soil Conservation Service, Soil Survey Laboratory, in Lincoln, Nebraska. Profiles of Alcester, Betts, Dudley, Hord, and Moody soils were sampled in Cedar County. The data for these soils as well as for most of the other soils that were correlated in Cedar County are available at the Soil Survey Laboratory. Profiles of Alcester, Betts, Boyd, Crofton, Gavins, Hobbs, Lamo, Moody, Nora, Ortello, Redstoe, and Thurman soils were sampled in nearby counties. The data for these soils are also available at the Soil Survey Laboratory, and some of these data are recorded in Soil Survey Investigations Report Number 5 (9).

Soil laboratory data are used by soil scientists in classifying soils and in developing concepts of soil genesis. They are also used in estimating soil properties, such as available water capacity, susceptibility to erosion, fertility, and tilth.

## Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil Series and Their

Morphology.” The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—

D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM); Specific gravity—T 100 (AASHTO). The group index number that is part of the AASHTO classification is computed by using the Nebraska modified system.



# Classification of the Soils

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The system of soil classification used by the National Cooperative Soil Survey has six categories (12). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

**ORDER.** Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

**SUBORDER.** Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittently dry, plus *oll*, from Mollisol).

**GREAT GROUP.** Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplustolls (*Hapl*, meaning minimal horizonation, plus *ustolls*, the suborder of the Mollisols that have an ustic moisture regime).

**SUBGROUP.** Each great group has a typical subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic*, for instance, identifies the subgroup that has a greater supply of moisture than typical of the great group. An example is Udic Haplustolls.

**FAMILY.** Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where

there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, mesic Udic Haplustolls.

**SERIES.** The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

## Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (8). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (12). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

### Albaton Series

The Albaton series consists of deep, poorly drained and very poorly drained soils on bottom lands. Permeability is slow. The soils formed in stratified, calcareous clayey sediment. The slope ranges from 0 to 2 percent.

Albaton soils are similar to Baltic soils and are commonly adjacent to Blake, Modale, Onawa, and Percival soils. Baltic soils have a thick mollic epipedon. Blake, Modale, and Onawa soils are on less depressional landscapes, slightly higher than Albaton

soils. Blake soils are somewhat poorly drained and contain less clay throughout than Albaton soils. Modale soils are moderately well drained and contain more silt and less clay in the upper part of the profile than Albaton soils. Onawa soils are loamy in the lower part of the profile. Percival soils are somewhat poorly drained and are sandy in the lower part of the profile.

Typical pedon of Albaton silty clay, 0 to 2 percent slopes, 1,000 feet west and 1,500 feet north of the southeast corner of sec. 14, T. 33 N., R. 1 W.

- Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; very hard, firm; common fine roots; few fine prominent white (10YR 8/1, moist) thin shell fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.
- C1—7 to 18 inches; dark gray (10YR 4/1) silty clay, dark grayish brown (2.5Y 4/2) moist; common fine faint grayish brown (2.5Y 5/2, moist) and distinct dark brown (7.5YR 3/2, moist) mottles; bedding planes are common; very hard, firm; few fine roots; few thin prominent white (10YR 8/1, moist) shell fragments; thin patchy black (N 2/0, moist) organic coatings on vertical and horizontal faces of peds; strong effervescence; mildly alkaline; abrupt smooth boundary.
- C2—18 to 29 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; many medium faint grayish brown (2.5Y 5/2, moist) and distinct light olive brown (10YR 5/4, moist) mottles; bedding planes are common; very hard, firm; few fine roots; very few thin prominent white (10YR 8/1, moist) shell fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.
- C3—29 to 36 inches; gray (N 5/0) clay, very dark gray (N 3/0) moist; massive; hard, firm; few fine roots; few thin prominent white (10YR 8/1, moist) shell fragments; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.
- C4—36 to 60 inches; gray (5Y 5/1) silty clay, dry and moist; common medium distinct light olive brown (10YR 5/4, moist) and common fine prominent dark brown (7.5YR 3/2, moist) mottles; massive; hard, firm; few fine roots; few thin prominent white (10YR 8/1, moist) shell fragments; violent effervescence; mildly alkaline.

The solum is 6 to 9 inches thick. Calcium carbonates are mostly at the surface or are within 10 inches of the surface.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4, moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam and clay.

The C horizon has hue of 5Y, 2.5Y, or 10YR, value of 3 through 6 (dry and moist), and chroma of 0 through 2.

It contains common or many mottles within a depth of 12 inches.

## Alcester Series

The Alcester series consists of deep, well drained soils on upland foot slopes. Permeability is moderate. The soils formed in silty colluvium. The slope ranges from 2 to 25 percent.

Alcester soils are commonly adjacent to Aowa, Crofton, Hord, Moody, and Nora soils. Aowa soils are on bottom lands and are stratified throughout. Crofton soils do not have a mollic epipedon, have free carbonates at or near the surface, and are on side slopes above Alcester soils. Hord soils are on terraces and have calcium carbonates above a depth of 48 inches. Moody soils have a thinner mollic epipedon and are on side slopes above Alcester soils. Nora soils have a thinner mollic epipedon, have calcium carbonate within a depth of 10 to 30 inches, and are on side slopes above Alcester soils.

Typical pedon of Alcester silt loam, 2 to 6 percent slopes, in a cultivated field, 1,000 feet east and 350 feet north of the southwest corner of sec. 21, T. 29 N., R. 2 E.

- Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; neutral; clear smooth boundary.
- A—8 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.
- BA—14 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, firm; neutral; gradual smooth boundary.
- Bw—25 to 34 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm; slightly acid; gradual smooth boundary.
- BC—34 to 49 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; dark organic coatings on vertical faces of few peds; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm; slightly acid; gradual smooth boundary.
- C1—49 to 57 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, firm; neutral; gradual smooth boundary.
- C2—57 to 60 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; massive; slightly hard, firm; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 48 to 60 inches. The mollic epipedon ranges from 24 to 50 inches in thickness and extends into the Bw horizon.

The A horizon has value of 3 or 4 (2 or 3, moist) and chroma of 1 or 2. It is silt loam or silty clay loam. The Bw horizon has value of 4 or 5 (2 through 4, moist) and chroma of 1 through 3.

The C horizon has value of 5 or 6 (3 through 5, moist) and chroma of 2 through 4. It is silt loam or silty clay loam. It ranges from neutral to moderately alkaline.

## Aowa Series

The Aowa series consists of deep, well drained soils on bottom lands. Permeability is moderate. The soils formed in calcareous silty alluvium. The slope ranges from 0 to 2 percent.

Aowa soils are similar to Hobbs and Shell soils and are adjacent to Alcester and Hord soils. Hobbs soils are in landscape positions similar to those of Aowa soils but do not have calcium carbonates in the upper part of the profile. Shell, Alcester, and Hord soils have a mollic epipedon and are in higher positions on the landscape than Aowa soils.

Typical pedon of Aowa silt loam, 0 to 2 percent slopes, 400 feet west and 400 feet north of the southeast corner, sec. 9, T. 30 N., R. 1 W.

- Ap—0 to 9 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; hard, friable; strong effervescence; moderately alkaline; abrupt smooth boundary.
- C1—9 to 15 inches; brown (10YR 5/3) silt loam, very dark gray (10YR 3/1) and dark brown (10YR 4/3) moist; massive with thin bedding planes; hard, friable; strong effervescence; mildly alkaline; clear smooth boundary.
- C2—15 to 25 inches; dark grayish brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) and grayish brown (10YR 5/2) moist; massive with thin bedding planes; slightly hard, friable; few fine distinct dark brown (7.5YR 4/4) stains on walls of root channels; few medium lime concretions; strong effervescence; mildly alkaline; clear smooth boundary.
- C3—25 to 38 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/2) and brown (10YR 5/3) moist; massive with thin bedding planes; hard, friable; slight effervescence; mildly alkaline; clear smooth boundary.
- C4—38 to 60 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) and brown (10YR 5/3) moist; massive with thin bedding planes; hard, friable; slight effervescence; mildly alkaline.

The solum and the A horizon are 10 inches thick or less. Aowa soils are calcareous throughout. Reaction is mildly alkaline or moderately alkaline.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 through 3. Its texture is dominantly silt loam, but the range includes silty clay loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 through 6 (3 through 5, moist), and chroma of 1 through 3. The horizon is dominantly silt loam, but the range includes silty clay loam. There are strata or lenses of various silty or loamy textures in some pedons.

## Baltic Series

The Baltic series consists of deep, poorly drained soils on bottom lands. Permeability is slow. The soils formed in silty and clayey alluvium. The slope ranges from 0 to 2 percent.

Baltic soils are similar to Albaton and Lamo soils and are commonly adjacent to Lamo and Shell soils. Albaton soils do not have a thick, dark surface layer. Lamo soils are on landscapes similar to those of Baltic soils but contain less clay throughout the profile than Baltic soils. Shell soils are well drained, contain less clay than Baltic soils, and are in higher positions on the landscape.

Typical pedon of Baltic silty clay loam, 0 to 2 percent slopes, 1,900 feet west and 600 feet south of the northeast corner of sec. 14, T. 28 N., R. 3 E.

- Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; mildly alkaline; clear smooth boundary.
- A—6 to 14 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; slightly hard, friable; slight effervescence; mildly alkaline; gradual smooth boundary.
- Bw1—14 to 25 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate medium subangular blocky structure; very hard, firm; few fine and medium lime segregations; strong effervescence; mildly alkaline; gradual smooth boundary.
- Bw2—25 to 40 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium angular blocky structure; very hard, firm; many medium soft lime segregations and a few nodular concretions; violent effervescence; mildly alkaline; gradual smooth boundary.
- C1—40 to 50 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; few fine distinct dark brown (10YR 4/3, moist) mottles; moderate medium angular blocky structure; very hard, firm; few fine and medium soft lime concretions; violent effervescence; mildly alkaline; gradual smooth boundary.



C2—50 to 60 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; few fine distinct dark brown (10YR 4/3, moist) mottles; massive; very hard, firm; many medium soft lime segregations and a few nodular concretions; violent effervescence; mildly alkaline.

The solum ranges from 30 to 45 inches in thickness. Calcium carbonates are within a depth of 10 inches. The mollic epipedon ranges from 30 to 45 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR or 2.5Y, value of 3 through 5 (2 or 3, moist), and chroma of 1 or 0. The Bw horizon has hue of 10YR or 2.5Y, value of 3 through 5 (2 or 3, moist), and chroma of 1 or 0. It is silty clay loam, silty clay, or clay. There are few or common faint or distinct mottles in the lower part. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6 (3 or 4, moist), and chroma of 1 or less.

### Barney Variant

The Barney Variant consists of deep, very poorly drained soils on bottom lands. Permeability is rapid. The soils formed in stratified, calcareous sandy alluvium. The slope ranges from 0 to 2 percent.

Barney Variant soils are commonly adjacent to Grable and Sarpy soils on the landscape. Grable and Sarpy soils are in higher positions on the landscape than Barney Variant soils. Grable soils are well drained and contain more silt in the upper part of the profile than Barney Variant soils. Sarpy soils are excessively drained.

Typical pedon of Barney Variant fine sand, 0 to 2 percent slopes, 250 feet east and 2,600 feet north of the southwest corner of sec. 11, T. 33 N., R. 1 E.

A—0 to 4 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; many medium distinct yellowish brown (10YR 5/6, moist) mottles; weak medium granular structure; loose; many fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C1—4 to 8 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; common medium distinct yellowish brown (10YR 5/4, moist) mottles; single grained; stratified, weak medium bedding planes; loose; common fine roots; moderately alkaline; clear smooth boundary.

C2—8 to 11 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; common coarse distinct yellowish brown (10YR 5/6, moist) mottles; single grained; stratified, weak medium bedding planes; loose; common fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C3—11 to 33 inches; light brownish gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2, moist); common

coarse prominent brown and strong brown (7.5YR 4/4 and 7.5YR 5/6, moist) mottles; single grained; stratified, weak medium bedding planes; loose; few fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

C4—33 to 60 inches; light gray (5Y 7/1) fine sand, gray (5Y 5/1) moist; single grained; stratified, weak thick bedding planes; loose; slight effervescence; moderately alkaline.

The solum is 3 to 10 inches thick. Calcium carbonates are within 10 inches of the surface.

The A horizon has hue of 10YR and 2.5Y, value of 4 through 6 (3 through 5, moist), and chroma of 0 through 2. The C horizon has hue of 10YR and 2.5Y, value of 4 through 7 (3 through 5, moist), and chroma of 0 through 2. Its texture is fine sand, loamy fine sand, and sand.

### Betts Series

The Betts series consists of deep, well drained and somewhat excessively drained soils on uplands. Permeability is moderate in the solum and moderately slow in the underlying material. The soils formed in loamy glacial till. The slope ranges from 6 to 30 percent.

Betts soils are commonly adjacent to Loretto, Simeon, Talmo, and Thurman soils. Loretto soils contain calcium carbonates at a greater depth than Betts soils and formed in loamy eolian material. Unlike Betts soils, Simeon and Thurman soils are sandy throughout, and Talmo soils are sandy and contain gravel.

Typical pedon of Betts clay loam, 6 to 15 percent slopes, 2,300 feet west and 1,250 feet south of the northeast corner of sec. 20, T. 31 N., R. 2 E.

Ap—0 to 4 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak coarse granular structure; very hard, firm; common fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

Bw—4 to 9 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, firm; common fine roots; strong effervescence; mildly alkaline; clear wavy boundary.

Ck—9 to 31 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; common fine distinct grayish brown (10YR 5/2, moist) and yellowish brown (10YR 5/6, moist) mottles; massive with medium angular blocky till fragments; very hard, firm; few fine roots on vertical seam faces; few coarse prominent white accumulations of (10YR 8/2, moist) soft calcium carbonate; few medium prominent black (10YR 2/1, moist) iron-manganese segregations; strong effervescence; mildly alkaline; clear wavy boundary.

C—31 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many coarse prominent yellowish brown (10YR 5/6, moist) mottles; massive; very hard, firm; few fine roots on upper part of vertical seam faces; few medium prominent white accumulations of (10YR 8/2) firm calcium carbonate; coarse medium prominent black iron-manganese stains; strong effervescence; mildly alkaline.

The solum is less than 10 inches thick. Calcium carbonates are at a depth of 0 to 3 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 through 6 (2 through 5, moist), and chroma of 1 through 3. Reaction is neutral through moderately alkaline.

The Bw horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5, moist), and chroma of 2 or 3. It is clay loam or loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon has hue of 2.5Y or 5Y, value of 5 through 7 (4 through 6, moist), and chroma of 2 through 4. Its texture is dominantly clay loam, but the range includes loam. The horizon is mildly alkaline or moderately alkaline.

### Blake Series

The Blake series consists of deep, somewhat poorly drained soils on bottom lands. Permeability is moderate. The soils formed in stratified, calcareous, silty and loamy alluvium. The slope ranges from 0 to 2 percent.

Blake soils are commonly adjacent to Grable, Modale, Onawa, and Sarpy soils. Blake soils and the adjacent soils are in similar positions on the landscape. Grable soils are well drained, have less clay in the upper part of the profile than Blake soils, and are sandy in the lower part of the profile. Modale soils are clayey in the lower part of the profile. Onawa soils are clayey in the upper part of the profile and loamy in the lower part. Sarpy soils are excessively drained and are sandy throughout.

Typical pedon of Blake silty clay loam, 0 to 2 percent slopes, 900 feet west and 2,800 feet north of the southeast corner of sec. 10, T. 33 N., R. 1 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; common fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1—8 to 24 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; few fine distinct dark yellowish brown (10YR 4/6, moist) mottles, mainly on surfaces of bedding planes; massive with weak thin bedding planes; slightly hard, friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

C2—24 to 60 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 4/2) moist; common fine

and medium distinct yellowish brown (10YR 5/6, moist) mottles, mainly on the surfaces of bedding planes; massive with weak thin and medium bedding planes; hard, friable; strong effervescence; moderately alkaline.

The solum ranges from 6 to 10 inches in thickness. Calcium carbonates are at the surface or within a depth of 10 inches. The soil is mildly alkaline or moderately alkaline throughout.

The A horizon has value of 3 through 5 (3 or 4, moist) and chroma of 1 or 2. Its texture is silty clay loam or silt loam. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6 (4 or 5, moist), and chroma of 2. Its texture is silty clay loam, silt loam, or very fine sandy loam.

### Blendon Series

The Blendon series consists of deep, well drained soils on terraces and alluvial fans. Permeability is moderately rapid in the solum and rapid in the underlying material. The soils formed in loamy and sandy eolian material and in glacial outwash. The slope ranges from 0 to 6 percent.

Blendon soils are similar to Maskell soils and are commonly adjacent to Loretto, Nimbro, Ortello, and Thurman soils on the landscape. Maskell and Blendon soils are in similar positions on the landscape. Maskell soils have more clay throughout than Blendon soils, and Loretto soils have more clay in the subsoil. Loretto and Ortello soils have a mollic epipedon that is less than 20 inches thick. These soils formed in higher positions on uplands. Nimbro soils are in lower positions on the landscape adjacent to waterways, have more clay throughout than Blendon soils, and are stratified. They are also subject to occasional flooding. Thurman soils formed in higher upland positions, have less clay throughout than Blendon soils, and have a mollic epipedon that is less than 20 inches thick.

Typical pedon of Blendon fine sandy loam, 2 to 6 percent slopes, 2,100 feet west and 1,300 feet south of the northeast corner of sec. 32, T. 32 N., R. 1 W.

A1—0 to 11 inches; very dark grayish brown (10YR 3/2) fine sandy loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; slightly acid; clear wavy boundary.

A2—11 to 19 inches; very dark grayish brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak medium granular structure; slightly hard, friable; slightly acid; clear wavy boundary.

Bw—19 to 39 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable; slightly acid; clear wavy boundary.

- BC—39 to 44 inches; dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, friable; slightly acid; clear wavy boundary.
- C1—44 to 51 inches; brown (10YR 5/3) fine sand, brown (10YR 4/3) moist; massive; soft, very friable; neutral; gradual wavy boundary.
- C2—51 to 60 inches; pale brown (10YR 6/3) fine sand, yellowish brown (10YR 5/4) moist; single grain; soft, very friable; neutral.

The solum ranges from 24 to 50 inches in thickness. Calcium carbonates are at a depth ranging from 40 to 60 inches or more. The mollic epipedon ranges from 20 to 50 inches in thickness.

The A horizon has value of 3 or 4 (2 or 3, moist) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes sandy loam and loam. Reaction is neutral through medium acid.

The Bw horizon has value of 3 or 4 (2 or 3, moist) and chroma of 1 or 2. Its texture is sandy loam, fine sandy loam, or loam. Reaction is slightly acid or neutral.

The C horizon has value of 5 through 7 (3 through 5, moist) and chroma of 2 through 4. Its texture is fine sand, loamy sand, loamy fine sand, sandy loam, fine sandy loam, coarse sand, or loamy coarse sand. Reaction is neutral through moderately alkaline.

## Boyd Series

The Boyd series consists of moderately deep, well drained soils on uplands. Permeability is very slow. The soils formed in residuum of calcareous bedded shale. The slope ranges from 6 to 15 percent.

Boyd soils are commonly adjacent to Betts and Redstoe soils. Betts soils are in positions on the landscape similar to those of Boyd soils. Unlike Boyd soils, Betts soils formed in glacial till; they have less clay throughout than Boyd soils. Redstoe soils have more silt and less clay, are downslope from Boyd soils in less sloping positions on the landscape, and formed in residuum of chalky siltstone.

Typical pedon of Boyd silty clay, 6 to 11 percent slopes, 600 feet east and 1,350 feet north of the southwest corner of sec. 31, T. 33 N., R. 1 W.

- Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; common fine roots; neutral; clear smooth boundary.
- Bw1—6 to 15 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine angular blocky structure; extremely hard, very firm; few fine roots; common medium soft yellowish brown (10YR 5/6, moist) iron concretions; few fine white (10YR 8/1, moist) calcium carbonate concretions; slight effervescence; mildly alkaline; gradual wavy boundary.

- Bw2—15 to 26 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium subangular blocky structure; extremely hard, very firm; few fine roots; few fine yellowish brown (10YR 5/6, moist) soft iron concretions; few fine white (10YR 8/1, moist) soft calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual wavy boundary.
- C—26 to 38 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, extremely firm; few coarse yellowish brown (10YR 5/6, moist) soft iron concretions; few fine gray (10YR 7/2, moist) calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.
- Cr—38 to 60 inches; light brownish gray (2.5Y 6/2) bedded shale, grayish brown (2.5Y 5/2) moist; common iron and calcium carbonate accumulations along weathering seams and fractures; strong effervescence; mildly alkaline.

The solum is 17 to 33 inches thick. Calcium carbonates are at a depth of 0 to 18 inches. The mollic epipedon is 7 to 15 inches thick. Shale is at a depth of 20 to 40 inches.

The A horizon has hue of 2.5Y or 10YR, value of 4 or 5 (2 or 3, moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes clay. Reaction is neutral through moderately alkaline.

The Bw horizon has hue of 2.5Y or 10YR, value of 4 through 6 (3 through 5, moist), and chroma of 1 through 3. It has a clay content of 50 to 60 percent. Reaction is mildly alkaline or moderately alkaline.

The C horizon has hue of 2.5Y and 10YR, value of 4 through 6 (4 or 5, moist), and chroma of 2 or 3. Reaction is neutral through moderately alkaline.

## Colo Series

The Colo series consists of deep, somewhat poorly drained, moderately slowly permeable soils on bottom lands. The soils formed in silty alluvium. The slope ranges from 0 to 2 percent.

Colo soils are commonly adjacent to Alcester, Aowa, Baltic, and Shell soils. Alcester soils are well drained and are in higher positions on the landscape than Colo soils. Aowa soils are well drained. Baltic soils are in positions on the landscape similar to those of Colo soils, but Baltic soils have carbonates within 10 inches of the surface and have more clay throughout. Shell soils are well drained and are slightly higher than Colo soils on the landscape.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, in a cultivated field, 1,500 feet south and 50 feet west of the northeast corner of sec. 11, T. 28 N., R. 2 E.

- Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many medium pores; medium acid; abrupt smooth boundary.
- A1—7 to 17 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak fine subangular blocky structure; slightly hard, friable; many medium pores; slightly acid; diffuse smooth boundary.
- A2—17 to 27 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine subangular blocky structure; slightly hard, friable; many medium pores; slightly acid; diffuse smooth boundary.
- Bw—27 to 36 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable; many medium pores; slightly acid; diffuse smooth boundary.
- C1—36 to 42 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; few fine distinct dark brown (7.5YR 4/4) mottles; weak coarse prismatic structure; hard, friable; many medium pores; slightly acid; clear smooth boundary.
- C2—42 to 60 inches; grayish brown (2.5YR 5/2) silty clay loam, dark grayish brown (2.5YR 4/2) moist; few fine distinct dark brown (7.5YR 4/4) and few medium distinct strong brown (7.5YR 5/6) mottles; massive; hard, friable; many medium pores; slightly acid.

The solum is 36 to 50 inches thick. The mollic epipedon is 36 to 60 inches thick. There are no calcium carbonates in the solum, and carbonates commonly have been leached to a depth of more than 60 inches. Reaction is medium acid or slightly acid to a depth of 12 inches and slightly acid or neutral below that depth.

The A horizon has value of 3 or 4 (2 or 3, moist) and chroma of 1. It is dominantly silty clay loam, but in some pedons there are subhorizons of silt loam. In most pedons there is a B horizon, but in some pedons there is an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 through 4, moist), and chroma of 1 or 2.

## Crofton Series

The Crofton series consists of deep, well drained to excessively drained, moderately permeable soils on uplands. The soils formed in silty, calcareous loess. The slope ranges from 2 to 60 percent.

Crofton soils are commonly adjacent to Alcester, Moody, and Nora soils on the landscape. Alcester soils are on foot slopes below Crofton soils. Moody and Nora soils are on plane, slightly concave, or slightly convex slopes. They and the Crofton soils are on a similar landscape. Unlike Crofton soils, the adjacent soils have

a mollic epipedon and a developed subsoil. In addition, calcium carbonates in these soils are leached to a greater depth.

Typical pedon of Crofton silt loam, in an area of Crofton-Nora complex, 6 to 11 percent slopes, eroded, 2,000 feet south and 500 feet east of the northwest corner of sec. 28, T. 29 N., R. 1 E.

- Ap—0 to 5 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.
- AC—5 to 12 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, friable; common fine roots; few accumulations of white soft calcium carbonate and common medium calcium carbonate concretions; violent effervescence; moderately alkaline; clear wavy boundary.
- C1—12 to 22 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) relict mottles; massive; slightly hard, friable; few fine roots; few fine prominent streaks of white soft calcium carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.
- C2—22 to 60 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; common medium faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) relict mottles; massive; slightly hard, friable; few fine roots; few fine faint streaks of white soft calcium carbonate; violent effervescence; moderately alkaline.

The solum is 6 to 15 inches thick. The depth to calcium carbonates ranges from 0 to 8 inches. Reaction is mildly alkaline or moderately alkaline throughout.

The A horizon has value of 4 through 6 (3 or 4, moist) and chroma of 2 or 3. The AC horizon is like the C horizon, except that its color is intermediate between that of the A horizon and that of the C horizon. There is no AC horizon in some pedons. The C horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 through 4.

## Dudley Series

The Dudley series consists of deep, moderately well drained soils on uplands. Permeability is slow. The soils formed in calcareous loess more than 60 inches thick over loamy glacial outwash or glacial till. The slope ranges from 0 to 2 percent.

Dudley soils in Cedar County are considered to be taxadjuncts to the Dudley series because the mollic epipedon is thinner and the texture is siltier than is definitive for the Dudley series. In addition, these soils

formed in loess, whereas the typical Dudley soils formed in glacial till. These differences, however, do not affect the use or behavior of the soils.

Dudley soils are adjacent to Moody soils. Moody soils are on similar landscapes. Unlike Dudley soils, they have calcium carbonates at a depth of about 35 inches or more and do not have an E horizon. In addition, they are well drained and have less clay and salt in the subsoil than Dudley soils.

Typical pedon of Dudley silt loam, in an area of Dudley-Moody complex, 0 to 2 percent slopes, 500 feet east and 475 feet south of the northwest corner, sec. 30, T. 30 N., R. 3 E.

Ap—0 to 4 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; hard, firm; neutral; clear smooth boundary.

E—4 to 7 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine subangular blocky structure; hard, very firm; neutral; abrupt smooth boundary.

Btn1—7 to 11 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; weak coarse columnar structure parting to strong medium subangular blocky; extremely hard, very firm; thin nearly continuous grayish brown (10YR 5/2) coatings on top of columnar peds; strong effervescence; moderately alkaline; gradual smooth boundary.

Btn2—11 to 18 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse prismatic structure parting to strong medium subangular blocky; extremely hard, very firm; strong effervescence; moderately alkaline; gradual smooth boundary.

Btn3—18 to 26 inches; brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, firm; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—26 to 44 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable; violent effervescence; moderately alkaline; clear smooth boundary.

C2—44 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; soft, very friable; violent effervescence; mildly alkaline.

The solum is 19 to 37 inches thick. Calcium carbonates are at a depth of 6 to 21 inches. The mollic epipedon is 10 to 19 inches thick.

The A horizon has value of 4 or 5 (2 or 3, moist) and chroma of 1 or 2. The E horizon has value of 4 through 7 (3 to 5, moist) and chroma of 1 or 2. Reaction is medium acid through neutral.

The Btn horizon has value of 3 through 5 (2 through 4, moist) and chroma of 1 through 3. It is dominantly silty clay loam, but the range includes silty clay. Reaction is neutral through moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6, moist), and chroma of 2 through 4.

## Eltree Series

The Eltree series consists of deep, well drained soils on uplands and foot slopes. Permeability is moderate. The soils formed in silty loess. The slope ranges from 0 to 11 percent.

Eltree soils are commonly adjacent to Crofton, Gavins, Nora, and Redstoe soils. Crofton soils do not have a thick, dark surface layer and are generally on steeper slopes than Eltree soils. Gavins soils are shallow over soft calcareous siltstone and are generally on steeper slopes. Nora soils are in positions on the landscape similar to or steeper than those of Eltree soils, have a dark surface layer less than 20 inches thick, and generally have carbonates at a greater depth in the profile than Eltree soils. Redstoe soils are in positions on the landscape similar to those of Eltree soils, are moderately deep to soft calcareous siltstone, and have a dark surface layer less than 12 inches thick.

Typical pedon of Eltree silt loam, 2 to 6 percent slopes, 1,875 feet west and 3,550 feet north of the southeast corner of sec. 9, T. 33 N., R. 1 E.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; many fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—8 to 17 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse granular structure; slightly hard, friable; many fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

A2—17 to 26 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse granular structure; slightly hard, friable; common fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Bwk1—26 to 35 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; few soft calcium carbonate concretions and myceliumlike calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

Bwk2—35 to 42 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; slightly hard, friable; few fine roots; common soft

calcium carbonate concretions and myceliumlike calcium carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

BC—42 to 58 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak coarse subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C—58 to 60 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable; violent effervescence; moderately alkaline.

The solum is 35 to 60 inches thick. The mollic epipedon is 20 to 40 inches thick. Calcium carbonates are within 15 inches of the surface.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 through 3. It is dominantly silt loam, but the range includes loam and silty clay loam. Reaction ranges from neutral through moderately alkaline.

The Bw horizon has value of 5 through 7 (3 through 5, moist) and chroma of 2 through 4. Its texture is silt loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon has value of 6 or 7 (5 or 6, moist) and chroma of 2 through 4. Its texture is silt loam, loam, or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

## Fillmore Series

The Fillmore series consists of deep, poorly drained soils in depressions on nearly level uplands. Permeability is very slow. The soils formed in loess. The slope ranges from 0 to 1 percent.

Fillmore soils are commonly adjacent to Moody soils on the landscape. Moody soils are well drained, have less clay in the subsoil than Fillmore soils, and are in higher positions on the landscape.

Typical pedon of Fillmore silt loam, 0 to 1 percent slopes, 50 feet west and 700 feet south of the northeast corner of sec. 19, T. 29 N., R. 2 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine and medium subangular blocky structure; hard, friable; medium acid; abrupt smooth boundary.

A1—7 to 13 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine and medium granular structure; slightly hard, friable; medium acid; clear smooth boundary.

A2—13 to 17 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; soft, friable; many fine pores; medium acid; abrupt smooth boundary.

E—17 to 23 inches; gray (10YR 5/1) silt loam, dark gray (10YR 4/1) moist; weak thick platy structure parting to weak fine and medium granular; soft, very friable;

many fine pores; medium acid; abrupt smooth boundary.

Bt1—23 to 30 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong fine and medium subangular blocky structure; hard, firm; few fine pores; few fine iron-manganese oxide concretions; slightly acid; gradual smooth boundary.

Bt2—30 to 49 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong medium subangular blocky structure; hard, firm; few fine pores; neutral; gradual smooth boundary.

BC—49 to 58 inches; grayish brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; strong medium subangular blocky structure; hard, firm; few fine iron-manganese oxide concretions; neutral; gradual smooth boundary.

C—58 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; many medium distinct brownish yellow (10YR 6/6, moist) and strong brown (7.5YR 5/6, moist) mottles; massive; hard, firm; neutral.

The solum is 45 to 60 inches thick. Calcium carbonates are typically at a depth of more than 60 inches, but in some pedons they are at a depth between 45 and 60 inches.

The A horizon has value of 4 or 5 (2 or 3, moist) and chroma of 1 or 2. It is mainly silt loam, but in some areas it is silty clay loam. Reaction is medium acid or slightly acid.

The E horizon has value of 5 or 6 (4 or 5, moist) and chroma of 1. Reaction is medium acid or slightly acid. The Bt horizon has value of 3 through 5 (2 through 4, moist) and chroma of 1 or 2. Reaction is medium acid through neutral.

The BC horizon has hue of 10YR or 2.5Y, value of 5 or 6 (3 through 5, moist), and chroma of 2 or 3. Reaction is medium acid through neutral. The C horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6, moist), and chroma of 2 through 4. It is silty clay loam or silty clay. Reaction is neutral or mildly alkaline.

## Gavins Series

The Gavins series consists of shallow, well drained and somewhat excessively drained, moderately permeable soils on uplands. The soils formed in residuum of soft calcareous siltstone. The slope ranges from 6 to 40 percent.

Gavins soils are commonly adjacent to Betts, Boyd, Redstoe, and Thurman soils. Betts soils are in higher positions on the landscape than Gavins soils, are deep, and have more clay and sand. Boyd soils are in higher positions on the landscape than Gavins soils, are moderately deep, and have more clay. Unlike Gavins soils, Redstoe soils are moderately deep and have a mollic epipedon. Thurman soils are in higher positions on



the landscape than Gavins soils, are deep, and have more sand and less clay throughout.

Typical pedon of Gavins silt loam, 6 to 15 percent slopes, 400 feet east and 200 feet north of the center of sec. 16, T. 33 N., R. 1 E.

A—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; violent effervescence; mildly alkaline; abrupt smooth boundary.

AC—6 to 9 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine granular structure; slightly hard, very friable; violent effervescence; moderately alkaline; clear smooth boundary.

C—9 to 14 inches; very pale brown (10YR 8/3) silty clay loam, very pale brown (10YR 7/4) moist; massive; hard, friable; violent effervescence; moderately alkaline; clear wavy boundary.

Cr—14 to 60 inches; white (10YR 8/2) siltstone, very pale brown (10YR 8/4) moist; hard; violent effervescence; moderately alkaline.

The solum is 8 to 15 inches thick. Calcium carbonates are at the surface. Soft siltstone fragments are throughout the solum. Soft siltstone is at a depth of 10 to 20 inches. Reaction is neutral to moderately alkaline throughout.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. The AC horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 through 4. It is silty clay loam or silt loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 through 8 (5 through 7, moist), and chroma of 1 through 5. Seams of gypsum crystals, ranging from 1/4 to 3/4 inch in thickness, are on fracture planes in some pedons.

## Grable Series

The Grable series consists of deep, well drained soils on bottom lands. Permeability is moderate in the upper part and rapid in the lower part. The soils formed in calcareous, silty over sandy alluvium. The slope ranges from 0 to 2 percent.

Grable soils are commonly adjacent to Blake, Modale, and Sarpy soils on the landscape. Blake and Modale soils are slightly lower on the landscape than Grable soils. Blake soils are somewhat poorly drained and have more silt and clay throughout than Grable soils. Modale soils have more clay in the lower part of the profile than Grable soils and are moderately well drained. Sarpy soils are in positions on the landscape similar to or slightly higher than those of Grable soils. Unlike Grable soils, Sarpy soils are sandy in the upper part of the profile.

Typical pedon of Grable silt loam, 0 to 2 percent slopes, 1,500 feet west and 4,100 feet north of the southeast corner of sec. 10, T. 33 N., R. 1 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, friable; common fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

C1—7 to 26 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; few fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C2—26 to 36 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; few fine faint gray (10YR 5/1, moist) and yellowish brown (10YR 5/4, moist) mottles; single grained; loose; strong effervescence; moderately alkaline; clear smooth boundary.

2C3—36 to 60 inches; light gray (10YR 7/1) sand, light brownish gray (10YR 6/2) moist; few fine faint gray (10YR 5/1, moist) and yellowish brown (10YR 5/4, moist) mottles; single grained; loose; strong effervescence; moderately alkaline.

The solum is 6 to 10 inches thick. Calcium carbonates are at the surface or within a depth of 10 inches. The silty upper part of the profile is 18 to 30 inches thick, and the sandy lower part extends to a depth of more than 60 inches. Reaction is mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 3 through 5 (3, moist), and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6 (4 or 5, moist), and chroma of 2. Its texture is silt loam or very fine sandy loam. In some pedons there are lenses of finer or coarser texture.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 through 7 (4 through 6, moist), and chroma of 1 or 2. Its texture is fine sand, sand, or loamy sand.

## Hobbs Series

The Hobbs series consists of deep, well drained soils on bottom lands. Permeability is moderate. The soils formed in stratified, noncalcareous silty alluvium. The slope ranges from 0 to 2 percent.

Hobbs soils are similar to Aowa and Shell soils and are commonly adjacent to Alcester, Colo, Hord, and Shell soils. Aowa, Colo, and Shell soils are on landscapes similar to those of Hobbs soils. Unlike Hobbs soils, Aowa soils are calcareous in the upper part. Shell, Alcester, Colo, and Hord soils have a mollic epipedon and are not stratified in the surface layer. Alcester soils are on gently sloping or strongly sloping foot slopes. Colo soils are somewhat poorly drained. Hord soils have a B horizon and are on stream terraces. Shell soils are stratified between depths of 20 and 40 inches.

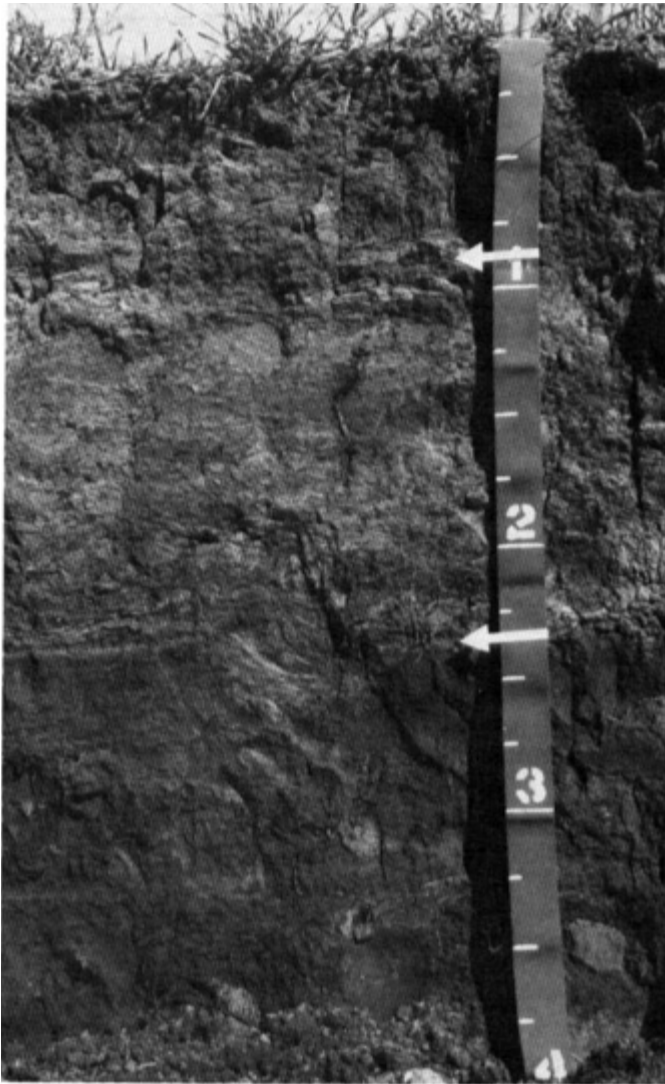


Figure 22.—Profile of Hobbs silt loam, 0 to 2 percent slopes. The stratified layers (arrows) were deposited by floodwaters. Depth is marked in feet.

Typical pedon of Hobbs silt loam, 0 to 2 percent slopes (fig. 22), 2,150 feet south and 100 feet east of the northwest corner of sec. 21, T. 30 N., R. 1 W.

- Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse granular structure; slightly hard, friable; many fine roots; mildly alkaline; clear smooth boundary.
- C1—8 to 15 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive with weak medium thick bedding planes; slightly hard, friable; many fine roots; mildly alkaline; abrupt smooth boundary.

C2—15 to 27 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; massive with weak medium thick bedding planes; soft, very friable; many fine roots; mildly alkaline; clear smooth boundary.

C3—27 to 41 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; massive with weak thick bedding planes; slightly hard, friable; many fine roots; mildly alkaline; abrupt smooth boundary.

Ab—41 to 60 inches; very dark grayish brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) moist; massive; soft, friable; few fine roots; mildly alkaline.

The solum and the A horizon are 6 to 9 inches thick.

The A horizon has value of 4 or 5 (2 or 3, moist) and chroma of 1 or 2. Its texture is dominantly silt loam, but the range includes silty clay loam. Reaction is slightly acid through mildly alkaline.

The C horizon is stratified in contrasting colors that have value of 4 through 7 (3 through 6, moist) and chroma of 1 through 3. It also has thin strata that have higher or lower value. The C horizon is silt loam or silty clay loam, but in some pedons there are subhorizons of various textures. Reaction is slightly acid through moderately alkaline. Buried soils are common below a depth of 20 to 45 inches.

## Hord Series

The Hord series consists of deep, well drained, moderately permeable silty soils on terraces. The soils formed in silty alluvium and loess. The slope ranges from 0 to 2 percent.

Hord soils are commonly adjacent to Alcester, Hobbs, Lamo, Redstoe, and Shell soils. Alcester soils are gently sloping or strongly sloping and are on foot slopes on uplands. Hobbs soils are in lower positions on the landscape than Hord soils, are stratified, and do not have a mollic epipedon. Lamo soils are in slightly lower positions than Hord soils and are somewhat poorly drained and poorly drained. They are subject to occasional flooding. Redstoe soils are higher on the landscape than Hord soils. They are moderately deep to calcareous siltstone and have a dark surface layer that is less than 15 inches thick. Shell soils do not have a developed subsoil, are stratified below a depth of 20 to 36 inches, and are in slightly lower positions on the landscape than Hord soils.

Typical pedon of Hord silt loam, 0 to 2 percent slopes, 1,100 feet east and 700 feet north of the southwest corner, sec. 6, T. 29 N., R. 1 E.

- Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard,

friable; many fine roots; medium acid; abrupt smooth boundary.

A—8 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse granular structure; hard, friable; many fine roots; medium acid; gradual wavy boundary.

Bw—14 to 26 inches; dark brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm; common fine roots; slightly acid; gradual wavy boundary.

BC—26 to 45 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate coarse subangular blocky structure; hard, firm; few fine roots; neutral; gradual wavy boundary.

C—45 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable; few soft and firm medium calcium carbonate concretions; strong effervescence; mildly alkaline.

The solum is 24 to 58 inches thick. The mollic epipedon, which extends into the Bw horizon, is 20 to 55 inches thick. Calcium carbonates are at a depth of 24 to 48 inches. Soft calcareous siltstone in the bedrock substratum is at a depth of 40 to 60 inches.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. Reaction is medium acid through neutral. The Bw horizon has colors similar to those of the A horizon. Texture of the A and Bw horizons is silt loam or silty clay loam.

The BC horizon has value of 4 through 6 (3 through 5, moist) and chroma of 2 or 3. Texture is silt loam or silty clay loam. Reaction is neutral or mildly alkaline.

The C horizon has value of 4 through 7 (3 through 6, moist) and chroma of 2 through 4. It is silt loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

## Inavale Series

The Inavale series consists of deep, excessively drained soils on bottom lands. Permeability is rapid. The soils formed in recent sandy alluvium. The slope ranges from 0 to 3 percent.

Inavale soils are similar to Sarpy soils and are adjacent to Nimbro soils on the landscape. Sarpy soils have finer sand throughout the profile than Inavale soils. Nimbro soils have less sand and more silt and clay than Inavale soils and are in similar positions on the landscape.

Typical pedon of Inavale coarse sand, channeled, 1,950 feet east and 2,600 feet north of the southwest corner, sec. 13, T. 30 N., R. 1 E.

A—0 to 8 inches; grayish brown (10YR 5/2) coarse sand, dark grayish brown (10YR 4/2) moist; single

grained; soft, loose; common fine roots; neutral; clear smooth boundary.

AC—8 to 20 inches; light brownish gray (10YR 6/2) coarse sand, dark grayish brown (10YR 4/2) moist; single grained; loose; few fine roots; neutral; clear smooth boundary.

C—20 to 60 inches; grayish brown (10YR 5/2) coarse sand, dark grayish brown (10YR 4/2) moist; single grained; soft, loose; thin lenses of loamy material; neutral.

The solum is 8 to 30 inches thick. Reaction is neutral or mildly alkaline throughout. Typically, there are no calcium carbonates in the profile, but some profiles have enough calcium carbonates to effervesce slightly.

The A horizon has value of 4 through 7 (3 through 5, moist) and chroma of 2 or 3. It is dominantly coarse sand, but the range includes textures varying from sand to silt loam. The AC horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 or 3. It is dominantly coarse sand, but the range includes fine sand, loamy sand, fine loamy sand, and sand.

The C horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 or 3. It is dominantly coarse sand, but the range includes loamy fine sand, loamy sand, fine sand, and sand. There are lenses and substrata of variable loamy and sandy textures throughout the profile.

## Kezan Series

The Kezan series consists of deep, poorly drained soils on bottom lands. Permeability is moderate. The soils formed in silty alluvium. The slope ranges from 0 to 2 percent.

Kezan soils in Cedar County are considered to be taxadjuncts to the Kezan series because they have carbonates throughout. This difference, however, does not affect the use or behavior of the soils.

Kezan soils are adjacent to Alcester, Aowa, Crofton, Hobbs, Moody, and Nora soils on the landscape. Alcester soils are on foot slopes above Kezan soils. Unlike Kezan soils, they are well drained and have a thick mollic epipedon. Aowa and Hobbs soils are well drained. They and Kezan soils are in similar positions on the landscape. Hobbs soils do not have carbonates. Crofton, Moody, and Nora soils are on uplands.

Typical pedon of Kezan silt loam, 0 to 2 percent slopes, 400 feet east and 425 feet south of the northwest corner of sec. 28, T. 28 N., R. 2 E.

A—0 to 5 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; abundant fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—5 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; massive with weak thin bedding planes; slightly hard, friable; abundant fine roots; continuous thin black (10YR 2/1) organic coatings on all faces of peds; few fine distinct dark brown (7.5YR 3/2, moist) iron oxide segregations oriented on surfaces of bedding planes; common fine prominent light gray (10YR 7/1, moist) calcium carbonate concretions; slight effervescence; mildly alkaline; clear smooth boundary.

C2—9 to 21 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; few fine distinct yellowish brown (10YR 5/6, moist) and few medium faint dark gray (10YR 4/1, moist) mottles; massive with weak thin bedding planes; hard, friable; common fine roots; common fine distinct dark brown (7.5YR 3/2, moist) iron oxide segregations oriented on surfaces of bedding planes; strong effervescence; mildly alkaline; clear smooth boundary.

C3—21 to 26 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist, including thin strata of grayish brown (10YR 5/2, moist) and dark grayish brown (10YR 4/2, moist); massive with weak thin bedding planes; hard, friable; common fine roots; common fine faint dark brown (7.5YR 3/2, moist) iron oxide segregations; slight effervescence; mildly alkaline; clear smooth boundary.

Ab1—26 to 33 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; massive; hard, friable; common fine faint dark brown (7.5YR 3/2) iron segregations; neutral; clear smooth boundary.

Ab2—33 to 60 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; common medium distinct dark brown (7.5YR 3/2, moist) mottles; massive; slightly hard, friable; neutral.

The solum is 4 to 9 inches thick. Calcium carbonates are at the surface or within a depth of 10 inches.

The A horizon has value of 4 or 5 (2 or 3, moist) and chroma of 1 or 2. Its texture is dominantly silt loam, but the range includes silty clay loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6 (2 through 4, moist), and chroma of 1 or 2. It is silt loam or silty clay loam. Reaction is neutral or mildly alkaline. A buried A horizon is below a depth of 24 inches.

## Lamo Series

The Lamo series consists of deep, somewhat poorly drained and poorly drained soils on bottom lands. Permeability is moderately slow. The soils formed in silty calcareous alluvium. The slope ranges from 0 to 2 percent.

Lamo soils are similar to Baltic and Colo soils and are commonly adjacent on the landscape to Aowa, Colo, and Shell soils. Baltic soils have more clay throughout the profile than Lamo soils. Colo soils do not have calcium carbonates in the solum. Aowa soils are well drained and are stratified throughout. Shell soils are in higher positions on the landscape than Lamo soils, are well drained, and do not have calcium carbonates above a depth of 48 inches.

Typical pedon of Lamo silty clay loam, 0 to 2 percent slopes, 100 feet west and 800 feet south of the northeast corner of sec. 31, T. 29 N., R. 3 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak fine and medium granular structure; slightly hard, friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

A—7 to 19 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; gradual smooth boundary.

AC—19 to 34 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; few fine distinct yellowish brown (10YR 5/4, moist) mottles; moderate medium subangular blocky structure; hard, firm; violent effervescence; moderately alkaline; gradual smooth boundary.

C1—34 to 44 inches; gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) moist; massive; hard, firm; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg1—44 to 55 inches; gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) moist; massive; hard, firm; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg2—55 to 60 inches; gray (5Y 6/1) silty clay loam, gray (5Y 5/1) moist; massive; hard, firm; large masses of calcium carbonate accumulations; violent effervescence; moderately alkaline.

The solum and the mollic epipedon range from 24 to 39 inches in thickness. Calcium carbonates are at the surface in most pedons; in the rest, they are within 10 inches of the surface.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly silty clay loam, but some subhorizons are silt loam.

The AC horizon has hue of 10YR and 2.5Y, value of 4 or 5 (2 or 3, moist), and chroma of 1 or 2. It is silty clay loam or silt loam. In some pedons there is no AC horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 through 7 (3 through 6, moist), and chroma of 1 or 2. It is silty clay loam or silt loam.

## Loretto Series

The Loretto series consists of deep, well drained soils on uplands. Permeability is moderate in the solum and rapid in the underlying material. The soils formed in loamy and silty loess over sand. The slope ranges from 2 to 11 percent.

Loretto soils are commonly adjacent to Moody, Ortello, and Thurman soils. They and the adjacent soils are on similar landscapes. Unlike Loretto soils, Moody soils are silty throughout, and Thurman soils are sandy throughout. Ortello soils have less clay in the solum than Loretto soils.

Typical pedon of Loretto loam, sand substratum, 2 to 6 percent slopes, 2,500 feet west and 900 feet south of the northeast corner, sec. 7, T. 32 N., R. 1 W.

- Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak medium and coarse granular structure; hard, friable; strongly acid; abrupt smooth boundary.
- A—8 to 11 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak medium and coarse granular structure; hard, friable; medium acid; clear wavy boundary.
- BA—11 to 19 inches; dark grayish brown (10YR 4/2) loam, dark brown (10YR 3/3) moist; weak fine and medium subangular blocky structure; hard, friable; slightly acid; clear wavy boundary.
- Bt—19 to 28 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable; slightly acid; clear wavy boundary.
- BC—28 to 42 inches; brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak coarse subangular blocky structure; hard, friable; few medium prominent soft white (10YR 8/2) calcium carbonate segregations; strong effervescence; mildly alkaline; clear wavy boundary.
- 2C1—42 to 55 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; loose, very friable; single grained; strong effervescence; mildly alkaline; gradual wavy boundary.
- 2C2—55 to 60 inches; pale brown (10YR 6/3) coarse sand, brown (10YR 5/3) moist; loose; single grained; strong effervescence; moderately alkaline.

The solum is 27 to 55 inches thick. Calcium carbonates are at a depth of 25 to 54 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam. It is strongly acid through slightly acid.

The Bt horizon has value of 4 through 6 (4 or 5, moist) and chroma of 2 or 3. It is dominantly loam or silt loam, but the range includes silty clay loam and clay loam. Reaction ranges from medium acid through neutral.

The BC and 2C horizons have hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6, moist), and chroma of 2 through 4. The BC horizon is sandy loam, loam, silt loam, silty clay loam, clay loam, or sandy clay loam. The BC and 2C horizons are slightly acid through moderately alkaline. The 2C horizon is coarse sand, gravelly coarse sand, fine sand, sand, or loamy sand.

## Maskell Series

The Maskell series consists of deep, well drained soils on terraces, alluvial fans, and foot slopes. Permeability is moderate. The soils formed in loamy alluvium and colluvium. The slope ranges from 0 to 6 percent.

Maskell soils are similar to Alcester, Blendon, and Hord soils and are commonly adjacent to Nimbro, Ortello, and Thurman soils. Alcester soils have less sand throughout than Maskell soils and are in similar positions on foot slopes. Blendon soils have more sand and less clay throughout than Maskell soils and are in similar positions on the landscape. Hord soils have less sand and more silt throughout than Maskell soils and are in similar positions on terraces. Nimbro soils are stratified and are in lower positions on bottom lands. Ortello and Thurman soils formed on uplands in higher positions on the landscape and have a mollic epipedon that is less than 20 inches thick. Ortello soils have more sand throughout than Maskell soils, and Thurman soils are sandy.

Typical pedon of Maskell loam, 2 to 6 percent slopes, 100 feet west and 2,220 feet south of the northeast corner of sec. 21, T. 32 N., R. 1 W.

- Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium granular structure; slightly hard, friable; many fine roots; mildly alkaline; abrupt smooth boundary.
- A1—6 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable; many fine roots; mildly alkaline; clear smooth boundary.
- A2—12 to 18 inches; very dark grayish brown (10YR 3/2) loam, black (10YR 2/1) moist; weak medium subangular blocky structure; slightly hard, friable; common fine roots; mildly alkaline; clear smooth boundary.
- Bw1—18 to 28 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; mildly alkaline; gradual smooth boundary.
- Bw2—28 to 37 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, friable; few fine roots; mildly alkaline; gradual smooth boundary.

BC—37 to 50 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak coarse subangular blocky structure; hard, firm; few fine roots; mildly alkaline; gradual smooth boundary.

C—50 to 60 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; hard, friable; few fine roots; strong effervescence; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. The mollic epipedon is 30 to 60 inches or more thick. Calcium carbonates are at a depth of 40 to 60 inches or more.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam, silt loam, and clay loam. It is medium acid through mildly alkaline.

The Bw horizon has value of 3 through 5 (2 through 4, moist) and chroma of 2 or 3. Its texture is loam, clay loam, sandy clay loam, or silty clay loam. The horizon is slightly acid through mildly alkaline.

The C horizon has value of 4 through 6 (3 through 5, moist) and chroma of 2 through 4. The horizon is dominantly loam or sandy loam, but the range includes sandy clay loam and fine sandy loam. It is neutral or mildly alkaline.

## Modale Series

The Modale series consists of deep, moderately well drained soils on bottom lands. Permeability is moderate in the upper part and is very slow in the lower part. The soils formed in stratified, calcareous, silty over clayey sediment. The slope ranges from 0 to 2 percent.

Modale soils are commonly adjacent to Albaton, Blake, Grable, Onawa, and Percival soils. Albaton soils are on lower depressional landscapes and have more clay in the upper part of the profile than Modale soils. Blake, Grable, and Onawa soils are all on similar landscapes. Blake soils are somewhat poorly drained and have more clay in the upper part of the profile and less clay in the lower part than Modale soils. Grable soils are sandy in the lower part of the profile. Onawa soils have more clay in the upper part of the profile and more silt in the lower part than Modale soils. Percival soils have more clay in the upper part of the profile and more sand in the lower part than Modale soils.

Typical pedon of Modale silt loam, 0 to 2 percent slopes, 1,200 feet east and 600 feet north of the southwest corner of sec. 10, T. 32 N., R. 3 E.

Ap—0 to 9 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium granular structure; soft, friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—9 to 29 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; weak thin and medium bedding planes; soft, friable; slight

effervescence; moderately alkaline; clear smooth boundary.

2C—29 to 60 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown mottles (10YR 5/6, moist); weak thick bedding planes; hard, very firm; few fine distinct white (10YR 8/1) thin shell fragments; slight effervescence; mildly alkaline.

The solum is 6 to 10 inches thick. Calcium carbonates are at or within 10 inches of the surface. The silty upper part of the profile is 18 to 30 inches thick, and the clayey lower part extends to a depth of more than 60 inches. Reaction is mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4, moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes subhorizons of very fine sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 through 6 (4 or 5, moist), and chroma of 2 through 4. Its texture is silt loam or very fine sandy loam, and there are lenses of loamy very fine sand in some pedons. The 2C horizon has hue of 10YR, 2.5Y, or N, value of 3 through 6 (3 through 5, moist), and chroma of 0 through 2. Its texture is clay or silty clay.

## Moody Series

The Moody series consists of deep, well drained soils on uplands. Permeability is moderately slow. The soils formed in loess. The slope ranges from 0 to 11 percent.

Moody soils are similar to Nora soils and are commonly adjacent to Alcester, Crofton, and Nora soils on the landscape. Nora soils have a thinner solum than Moody soils and are calcareous nearer the surface. Alcester soils have a mollic epipedon more than 20 inches thick; they are on lower foot slopes. Crofton soils do not have a mollic epipedon; they have calcium carbonates at or near the surface; and they are on narrow convex ridgetops or steeper side slopes.

Typical pedon of Moody silty clay loam, 2 to 6 percent slopes, eroded (fig. 23), 100 feet west and 2,000 feet south of the northeast corner of sec. 19, T. 29 N., R. 1 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; many fine roots; neutral; abrupt smooth boundary.

Bw1—6 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

Bw2—9 to 25 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium





Figure 23.—Profile of Moody silty clay loam, 2 to 6 percent slopes, eroded. This deep soil formed in loess. Depth is marked in feet.

prismatic structure parting to moderate fine and medium subangular blocky; hard, firm; few fine roots; neutral; gradual smooth boundary.

Bw3—25 to 34 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; few fine roots; neutral; clear wavy boundary.

BC—34 to 45 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; few fine faint grayish brown (10YR 5/2, moist) and yellowish brown (10YR 5/4, moist) relict mottles; weak coarse subangular

blocky structure; slightly hard, friable; neutral; clear wavy boundary.

C—45 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; few fine faint grayish brown (10YR 5/2, moist) and yellowish brown (10YR 5/6, moist) relict mottles; massive; slightly hard, friable; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to calcium carbonates range from 30 to 60 inches. The mollic epipedon colors extend to a depth of 6 to 20 inches.

The A horizon has value of 3 or 4 (2 or 3, moist) and chroma of 2. Typically, it is silty clay loam, but in some places it is silt loam. Reaction ranges from medium acid through neutral.

The Bw1 horizon has value of 3 or 4 (2 or 3, moist) and chroma of 2 or 3 (dry or moist). The rest of the Bw horizon has value of 5 or 6 (4 or 5, moist) and chroma of 2 through 4. The BC horizon is silt loam or silty clay loam. The Bw horizon is slightly acid or neutral, and the BC horizon is neutral or mildly alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 (5 or 6, moist), and chroma of 2 through 4. It has few or common relict mottles. It is silt loam or silty clay loam. Typically, in the upper part of the C horizon there are few or common concretions of calcium carbonate.

Moody soils in Cedar County, except for Moody silty clay loam, 0 to 2 percent slopes (Mo), are considered to be taxadjuncts to the Moody series because they do not have a mollic epipedon, which is a characteristic of the Moody series. This difference, however, does not affect the use or behavior of the soils.

## Nimbro Series

The Nimbro series consists of deep, well drained soils on bottom lands. Permeability is moderate. The soils formed in stratified, loamy and silty alluvium. The slope ranges from 0 to 2 percent.

Nimbro soils are similar to Aowa and Hobbs soils and are commonly adjacent on the landscape to Aowa, Hobbs, Inavale, Loretto, and Maskell soils. Aowa and Hobbs soils have less sand throughout than Nimbro soils and are in similar positions on the landscape. Inavale soils are sandy throughout and are in similar positions on the landscape. Loretto and Maskell soils are not stratified and are in upland positions on the landscape.

Typical pedon of Nimbro silt loam, 0 to 2 percent slopes, 350 feet west and 2,400 feet north of the southeast corner of sec. 5, T. 30 N., R. 3 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse granular structure; hard, friable; stratified with sandier material; slight effervescence; mildly alkaline; clear smooth boundary.

C1—7 to 43 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thin platy bedding planes; stratified with loam and sandy loam; hard, friable; slight effervescence; mildly alkaline; clear smooth boundary.

C2—43 to 56 inches; stratified grayish brown (10YR 5/2) and pale brown (10YR 6/3) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy bedding planes; hard, friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ab—56 to 60 inches; stratified dark grayish brown (10YR 4/2) and pale brown (10YR 6/3) loam, very dark brown (10YR 2/2) moist; massive; hard, friable; mildly alkaline.

The solum is 5 to 9 inches thick. Typically, Nimbro soils are calcareous throughout, but in some places there are thin layers that are noncalcareous. The soils are mildly alkaline or moderately alkaline throughout.

The A horizon has value of 4 or 5 (2 or 3, moist) and chroma of 2. It is dominantly silt loam, but the range commonly includes loam and very fine sandy loam.

The C horizon has value of 5 or 6 (3 through 5, moist) and chroma of 2 or 3. It is silt loam and loam.

## Nora Series

The Nora series consists of deep, well drained soils on uplands. Permeability is moderate. The soils are on side slopes and ridgetops. They formed in calcareous loess. The slope ranges from 2 to 15 percent.

Nora soils are similar to Moody soils and are adjacent to Alcester, Crofton, and Moody soils on the landscape. Moody soils have a thicker solum than Nora soils and have calcium carbonates at a greater depth. Alcester soils are on foot slopes and have a mollic epipedon that is more than 20 inches thick. Crofton soils are generally on more convex upper slopes. The soils are calcareous at or near the surface and do not have a mollic epipedon.

Typical pedon of Nora silty clay loam, 6 to 11 percent slopes, eroded (fig. 24), 400 feet east and 1,100 feet north of the southwest corner of sec. 18, T. 28 N., R. 1 E.

Ap—0 to 7 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate medium granular structure; slightly hard, friable; many fine roots; neutral; abrupt smooth boundary.

Bw1—7 to 14 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, friable; common fine roots; neutral; clear smooth boundary.

Bw2—14 to 20 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak coarse prismatic structure parting to moderate fine

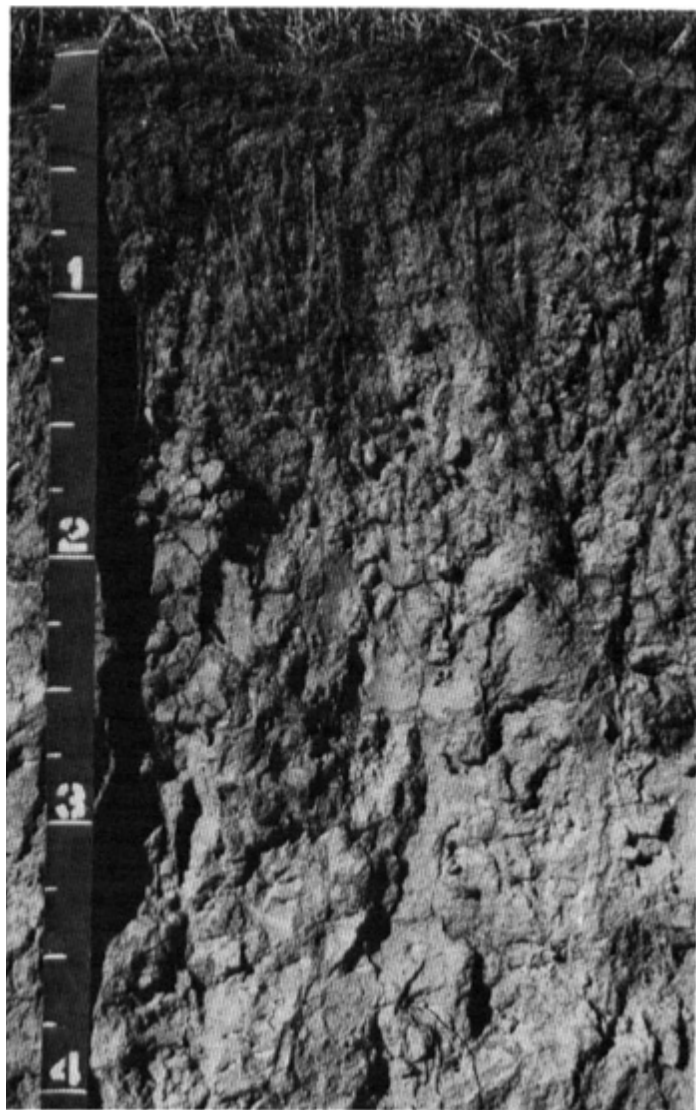


Figure 24.—Profile of Nora silty clay loam, 6 to 11 percent slopes, eroded. This soil formed in calcareous loess. Depth is marked in feet.

subangular blocky; hard, friable; common fine roots; neutral; clear wavy boundary.

BCk—20 to 28 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; hard, friable; few fine roots; few medium soft white (10YR 8/2, moist) calcium carbonate concretions; strong effervescence; mildly alkaline; clear wavy boundary.

Ck1—28 to 35 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; hard, friable; few fine roots; few medium and coarse, firm and hard, white (10YR 8/2, moist) calcium carbonate

concretions; strong effervescence; mildly alkaline; gradual wavy boundary.

Ck2—35 to 43 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; common medium faint yellowish brown (10YR 5/4, moist) and common fine faint dark brown (10YR 4/3, moist) relict mottles; massive; hard, friable; few medium and coarse, firm and hard, white (10YR 8/2, moist) calcium carbonate concretions; strong effervescence; mildly alkaline; gradual wavy boundary.

Ck3—43 to 60 inches; light gray (10YR 7/2) silt loam, light brownish gray (2.5Y 6/2) moist; common fine distinct light olive brown (2.5Y 5/6, moist) and common medium prominent yellowish brown (10YR 5/6, moist) relict mottles; massive; hard, friable; few fine soft white (10YR 8/2, moist) calcium carbonate concretions; strong effervescence; mildly alkaline.

The solum ranges from 20 to 36 inches in thickness. Calcium carbonates are at a depth of 13 to 30 inches. The mollic epipedon ranges from 7 to 15 inches in thickness.

The A horizon ranges from 4 to 12 inches in thickness. It has value of 3 through 5 (2 or 3, moist) and chroma of 2 or 3. It is mainly silty clay loam, but the range includes silt loam. Reaction is slightly acid or neutral.

The Bw horizon is silt loam or silty clay loam. It has value of 5 or 6 (3 through 5, moist) and chroma of 3 or 4. The B<sub>Ck</sub> horizon has hue of 10YR or 2.5Y, value of 5 through 7 (5 or 6, moist), and chroma of 3 or 4. The C<sub>k</sub> horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 through 4. It is mildly alkaline or moderately alkaline. There are few or common segregations of lime in the B<sub>Ck</sub> horizon and in the upper part of the C horizon.

The Nora soil that was mapped with a Crofton soil as Crofton-Nora complex, 11 to 15 percent slopes, eroded (CnE2), is a taxadjunct to the Nora series because it does not have a mollic epipedon, which is a characteristic of the Nora series. This difference, however, does not affect the usefulness or behavior of the soil.

## Onawa Series

The Onawa series consists of deep, somewhat poorly drained soils on bottom lands. Permeability is slow in the upper part of the profile and moderate in the lower part. The soils formed in calcareous, clayey over silty and loamy alluvium. The slope ranges from 0 to 2 percent.

Onawa soils are commonly adjacent to Albaton, Blake, Modale, and Percival soils. Albaton soils are in similar or lower positions on the landscape and have more clay in the lower part of the profile than Onawa soils. Blake, Modale, and Percival soils are all in similar positions on the landscape. Blake soils are somewhat poorly drained and have less clay in the upper part of the profile than

Onawa soils. Modale soils are moderately well drained and have more clay in the lower part of the profile than Onawa soils. Percival soils are sandy in the lower part of the profile.

Typical pedon of Onawa silty clay, 0 to 2 percent slopes, 1,940 feet west and 2,600 feet south of the northeast corner of sec. 15, T. 33 N., R. 1 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay; very dark gray (10YR 3/1) moist; moderate fine granular structure; very hard, firm; common fine roots; few fine distinct white (10YR 8/1) snail shell fragments; violent effervescence; mildly alkaline; abrupt smooth boundary.

C—8 to 22 inches; gray (10YR 5/1) silty clay, dark gray (10YR 4/1) moist; few fine distinct yellowish brown (5YR 4/6, moist) mottles; massive; very hard, firm; few fine roots; few fine and medium distinct white (10YR 8/1) snail shells; violent effervescence; moderately alkaline; clear wavy boundary.

2C1—22 to 26 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; many medium faint yellowish brown (10YR 5/6, moist) mottles; massive with weak thin bedding planes; hard, friable; few fine roots; few fine distinct white (10YR 8/1) calcium carbonate concretions; violent effervescence; moderately alkaline; clear wavy boundary.

2C2—26 to 60 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; many medium faint yellowish brown (10YR 5/6, moist) and few fine prominent yellowish red (5YR 4/6, moist) mottles; massive; soft, very friable; violent effervescence; moderately alkaline.

The solum is 6 to 9 inches thick. Calcium carbonates are at the surface or within a depth of 10 inches. The clayey upper part of the profile is 18 to 30 inches thick, and the silty and loamy lower part extends to a depth of more than 60 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 through 5 (3, moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam.

The C horizon has hue of 10YR and 2.5Y, value of 4 through 6 (4 or 5, moist), and chroma of 0 through 2. It is clay or silty clay. Reaction is mildly alkaline or moderately alkaline.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 through 6 (4 or 5, moist), and chroma of 0 through 2. It is silt loam, very fine sandy loam, or loam. Reaction is mildly alkaline or moderately alkaline.

## Ortello Series

The Ortello series consists of deep, well drained soils on uplands. Permeability is moderate. The soils formed



in loamy and sandy eolian material. The slope ranges from 2 to 15 percent.

Ortello soils are commonly adjacent to Betts, Blendon, Loretto, Talmo, and Thurman soils. Betts soils formed in glacial till and have more clay throughout than Ortello soils. Blendon soils are on terraces and alluvial fans and have a mollic epipedon that is more than 20 inches thick. Loretto soils have more clay in the subsoil than Ortello soils. Talmo soils are sandy throughout and formed in glacial outwash. Thurman soils are sandy throughout.

Typical pedon of Ortello sandy loam, 6 to 11 percent slopes, 1,850 feet east and 2,550 feet south of the northwest corner of sec. 12, T. 32 N., R. 1 W.

- Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.
- A—9 to 16 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; common fine roots; slightly acid; gradual wavy boundary.
- Bw—16 to 26 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, friable; common fine roots; neutral; gradual wavy boundary.
- BC—26 to 37 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; weak coarse subangular blocky structure; soft, very friable; few fine roots; neutral; gradual wavy boundary.
- C1—37 to 48 inches; pale brown (10YR 6/3, dry and moist) loamy fine sand; massive; soft, very friable; few very fine roots; neutral; gradual wavy boundary.
- C2—48 to 60 inches; very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) moist; massive; soft, very friable; neutral.

The solum is 24 to 50 inches thick. The mollic epipedon ranges from 8 to 20 inches in thickness. There are no carbonates in the upper 60 inches of the soil, except where there is finer textured material in the lower part of the subsoil or in the underlying material.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 through 3. It is dominantly sandy loam, but the range includes fine sandy loam and loam. Reaction is slightly acid or neutral.

The Bw horizon has value of 4 through 6, dry (3 through 5, moist) and chroma of 2 through 4. It is fine sandy loam or sandy loam. The clay content commonly decreases with increasing depth. Reaction is slightly acid or neutral.

The C horizon has value of 6 through 8 (5 or 6, moist) and chroma of 2 through 4. It is sandy loam, fine sandy loam, loamy fine sand, or loamy sand. Reaction is neutral or mildly alkaline.

## Percival Series

The Percival series consists of deep, somewhat poorly drained soils on bottom lands. Permeability is slow in the upper part of the profile and rapid in the lower part. The soils formed in calcareous, clayey over sandy alluvium. The slope ranges from 0 to 2 percent.

Percival soils are commonly adjacent to Albaton, Blake, Grable, Modale, and Onawa soils on the landscape. Albaton soils are in similar or lower positions on the landscape and have more clay in the lower part of the profile than Percival soils. Blake, Modale, and Onawa soils all are in similar positions on the landscape. Blake soils are silty throughout. Grable soils generally are slightly higher on the landscape and are silty in the upper part of the profile. Modale soils are moderately well drained and are clayey in the lower part of the profile. Onawa soils are loamy in the lower part of the profile.

Typical pedon of Percival silty clay, 0 to 2 percent slopes, 2,600 feet west and 1,250 feet south of the northeast corner of sec. 17, T. 33 N., R. 1 E.

- Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine subangular blocky structure; very hard, firm; slight effervescence; mildly alkaline; clear smooth boundary.
- C1—8 to 19 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (10YR 4/2) moist; common fine distinct dark brown (7.5YR 4/4, moist) mottles; massive with fine angular blocky cleavages; very hard, firm; slight effervescence; mildly alkaline; abrupt smooth boundary.
- 2C2—19 to 27 inches; light brownish gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; slight effervescence; mildly alkaline; gradual smooth boundary.
- 2C3—27 to 60 inches; light gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; slight effervescence; mildly alkaline.

The solum is 6 to 9 inches thick. Reaction is mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR or 2.5Y, value of 3 through 5 (2 or 3, moist), and chroma of 1 or 2.

The C horizon has value of 4 through 6 (4 or 5, moist) and chroma of 1 or 2. It is clay or silty clay.

The 2C horizon has hue of 2.5Y or 10YR, value of 5 through 7 (4 through 6, moist), and chroma of 2. It is fine sand or loamy fine sand. Thin lenses of finer or coarser texture are commonly present.

## Redstoe Series

The Redstoe series consists of moderately deep, well drained soils on uplands. Permeability is moderate. The

soils formed in residuum of soft calcareous siltstone. The slope ranges from 0 to 11 percent.

Redstoe soils are commonly adjacent to Boyd, Gavins, and Thurman soils. Boyd soils are in higher positions on the landscape and have much more clay throughout the profile than Redstoe soils. Gavins soils are on similar or steeper landscapes; they are shallow and do not have a mollic epipedon. Thurman soils are in higher positions on the landscape than Redstoe soils, are deep, and are sandy throughout.

Typical pedon of Redstoe silt loam, 2 to 6 percent slopes, 3,800 feet east and 2,600 feet north of the southwest corner of sec. 6, T. 31 N., R. 2 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; firm, friable; many fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

A—6 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky structure; firm, friable; common fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

AC—10 to 16 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; firm, friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Ck1—16 to 22 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; moderate fine subangular blocky pattern of seams of weathering; firm, friable; few fine roots along fracture planes; common fine distinct white (10YR 8/1, moist) calcium carbonate concretions; violent effervescence; gradual smooth boundary.

Ck2—22 to 27 inches; white (10YR 8/2) silt loam, pale brown (10YR 6/3) moist; massive; hard, friable; violent effervescence; mildly alkaline; gradual smooth boundary.

Cr—27 to 60 inches; very pale brown (10YR 8/3) siltstone, yellowish brown (10YR 5/4) moist; common fine and medium distinct yellowish red (5Y 4/6, moist) stains; massive; hard, firm.

The solum is 11 to 22 inches thick. Calcium carbonates are at the surface or within a depth of 6 inches. The mollic epipedon is 6 to 15 inches thick. Soft calcareous siltstone is at a depth of 20 to 40 inches.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly silt loam, but the range includes loam. Reaction is neutral through moderately alkaline.

The AC horizon has hue of 10YR or 2.5Y, value of 4 through 6 (3 through 5, moist), and chroma of 2 through 4. It is dominantly silt loam, but the range includes loam and silty clay loam. Reaction is mildly alkaline or moderately alkaline.

The Ck horizon has hue of 10YR or 2.5Y, value of 6 through 8 (4 through 6, moist), and chroma of 3 through 5. It is mildly alkaline or moderately alkaline. The calcium carbonate equivalent ranges from 30 to 70 percent.

## Sarpy Series

The Sarpy series consists of deep, excessively drained soils on bottom lands. Permeability is rapid. The soils formed in sandy alluvium. The slope ranges from 0 to 11 percent.

Sarpy soils are commonly adjacent to Blake, Grable, and Percival soils on the landscape. Blake soils are somewhat poorly drained and have more clay throughout than Sarpy soils. Grable soils are in similar or slightly lower positions on the landscape and are silty in the upper part of the profile. Percival soils are in lower depressional positions and are clayey in the upper part of the profile.

Typical pedon of Sarpy loamy fine sand, 0 to 3 percent slopes, from a cultivated field, 2,525 feet west and 550 feet north of the southeast corner of sec. 8, T. 33 N., R. 1 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

C1—8 to 16 inches; grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; soft, loose; slight effervescence; neutral; gradual smooth boundary.

C2—16 to 52 inches; pale brown (10YR 6/3) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; strong effervescence; mildly alkaline; gradual smooth boundary.

C3—52 to 60 inches; light gray (10YR 7/2) fine sand, pale brown (10YR 6/3) moist; single grained; loose; strong effervescence; mildly alkaline.

The solum is 1 inch to 8 inches thick. Calcium carbonates are within 10 inches of the surface. Reaction is neutral through moderately alkaline.

The A horizon has value of 4 through 6 (3 through 5, moist) and chroma of 1 through 3. Texture is loamy fine sand, fine sand, or fine sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 through 7 (4 through 6, moist), and chroma of 2 through 4. Its texture is fine sand, loamy fine sand, or sand.

## Shell Series

The Shell series consists of deep, well drained soils on bottom lands. Permeability is moderate. The soils formed in silty alluvium. The slope ranges from 0 to 2 percent.

Shell soils are similar to Aowa and Hobbs soils and are commonly adjacent to Alcester, Hobbs, and Hord soils. Aowa and Hobbs soils do not have a mollic epipedon and are stratified in the upper part of the profile. They are in slightly lower positions on the landscape than Shell soils. Alcester soils are not stratified and are on foot slopes on uplands. Hord soils are not stratified, are on terraces in slightly higher positions on the landscape than Shell soils, and have a developed subsoil.

Typical pedon of Shell silt loam, 0 to 2 percent slopes, 100 feet west and 1,800 feet north of the southeast corner of sec. 11, T. 30 N., R. 1 E.

- Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt smooth boundary.
- A1—8 to 16 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak coarse granular structure; hard, friable; many fine roots; slightly acid; gradual smooth boundary.
- A2—16 to 33 inches; dark gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; hard, friable; common fine roots; neutral; gradual smooth boundary.
- C1—33 to 52 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; massive with weak medium bedding planes; hard, firm; few fine roots; neutral; gradual smooth boundary.
- C2—52 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; massive with weak medium bedding planes; hard, firm; few fine roots; neutral.

The solum and the mollic epipedon are 20 to 36 inches thick. Calcium carbonates are at a depth of more than 48 inches.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 through 3. Reaction is medium acid through neutral.

The C horizon has value of 4 through 6 (3 through 5, moist) and chroma of 2 or 3. Its texture is silt loam or silty clay loam. Reaction ranges from slightly acid through mildly alkaline.

### Simeon Series

The Simeon series consists of deep, excessively drained soils on uplands. Permeability is rapid. The soils formed in sandy and loamy glaciofluvial deposits. The slope ranges from 9 to 30 percent.

Simeon soils in Cedar County are considered to be taxadjuncts to the Simeon series because the climate is more humid and the pH is higher than is typical for the

Simeon series. These differences, however, do not affect the use or behavior of the soils.

Simeon soils are commonly adjacent to Betts, Ortello, Talmo, and Thurman soils. Betts soils have more clay throughout the profile than Simeon soils. Ortello soils have less sand and more silt and clay than Simeon soils. Talmo soils have a mollic epipedon, and they have gravelly coarse sand and coarse sand at a depth of 7 to 20 inches. Thurman soils have a mollic epipedon and have no gravel.

Typical pedon of Simeon sandy loam, in an area of Simeon-Talmo-Ortello complex, 9 to 30 percent slopes, 1,700 feet west and 2,000 feet north of the southeast corner of sec. 8, T. 32 N., R. 1 E.

- A—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine and medium subangular blocky structure; soft, very friable; 3 percent pebbles; slightly acid; clear smooth boundary.
- AC—9 to 19 inches; dark grayish brown (10YR 4/2) coarse sand, dark brown (10YR 4/3) moist; single grained; loose; 12 percent pebbles; neutral; clear wavy boundary.
- C1—19 to 34 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) moist; single grained; loose; 9 percent pebbles; mildly alkaline; gradual wavy boundary.
- C2—34 to 60 inches; light gray (10YR 7/2) sand, light brownish gray (10YR 6/2) moist; single grained; loose; 7 percent pebbles; moderately alkaline.

The solum is 7 to 20 inches thick.

The A horizon has value of 3 through 6 (2 through 5, moist) and chroma of 1 or 2. It is dominantly sandy loam, but the range includes loamy sand, sand, and fine sand. Reaction is slightly acid or neutral.

The AC horizon has value of 4 through 6 (4 or 5, moist) and chroma of 2 or 3. It is dominantly coarse sand, but the range includes sand, loamy sand, and loamy coarse sand. Pebbles make up as much as 15 percent of the volume. Reaction is slightly acid or neutral.

The C horizon has value of 6 through 8 (5 through 7, moist) and chroma of 2 through 4. It is sand, loamy sand, coarse sand, or loamy coarse sand. Gravel makes up as much as 15 percent of the volume. Reaction is slightly acid through moderately alkaline.

### Talmo Series

The Talmo series consists of excessively drained soils on uplands. Permeability is rapid. The soils formed in loamy and sandy material over sand and gravel. The slope ranges from 3 to 30 percent.

Talmo soils in Cedar County are considered to be taxadjuncts to the Talmo series because they have less



gravel and a slightly thicker solum than is characteristic of the Talmo series; also, the pH of these soils is lower than is typical. These differences, however, do not affect the use or behavior of the soils.

Talmo soils are commonly adjacent to Betts, Loretto, Ortello, Simeon, and Thurman soils. Betts soils have considerably more silt and clay and less sand than Talmo soils. Loretto and Ortello soils have more clay and less sand in the profile above a depth of 40 inches than Talmo soils. Simeon soils do not have a mollic epipedon and have less gravel than Talmo soils. Thurman soils do not have gravel.

Typical pedon of Talmo sandy loam, in an area of Talmo-Loretto complex, 3 to 9 percent slopes, 1,600 feet west and 200 feet north of the southeast corner of sec. 30, T. 30 N., R. 2 E.

- A—0 to 7 inches; dark gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak medium granular structure; soft, very friable; strongly acid; abrupt smooth boundary.
- AC—7 to 18 inches; dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, loose; 2 percent small rounded igneous pebbles; slightly acid; abrupt smooth boundary.
- 2C1—18 to 36 inches; brown (10YR 5/3) gravelly coarse sand, brown (10YR 4/3) moist; single grained; loose; 34 percent rounded igneous pebbles; neutral; clear smooth boundary.
- 2C2—36 to 48 inches; yellowish brown (10YR 5/4) coarse sand, dark yellowish brown (10YR 4/4) moist; single grained; loose; 9 percent small rounded igneous pebbles; neutral; clear smooth boundary.
- 2C3—48 to 60 inches; pale brown (10YR 6/3) coarse sand, brown (10YR 5/3) moist; single grained; loose; 2 percent small rounded igneous pebbles; slightly acid.

The solum and the mollic epipedon are 7 to 20 inches thick.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly sandy loam, but the range includes fine sandy loam, loamy fine sand, loamy sand, gravelly coarse sandy loam, and sand. Reaction is strongly acid through mildly alkaline.

The AC horizon has value of 4 through 6 (3 or 4, moist) and chroma of 2 through 4. It is dominantly loamy sand, but the range includes gravelly loam, sandy loam, gravelly loamy coarse sand, and gravelly coarse sand. Reaction is strongly acid through mildly alkaline.

The 2C horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 through 4. It is coarse sand, gravelly coarse sand, gravelly sand, or very gravelly coarse sand. Reaction is slightly acid through moderately alkaline.

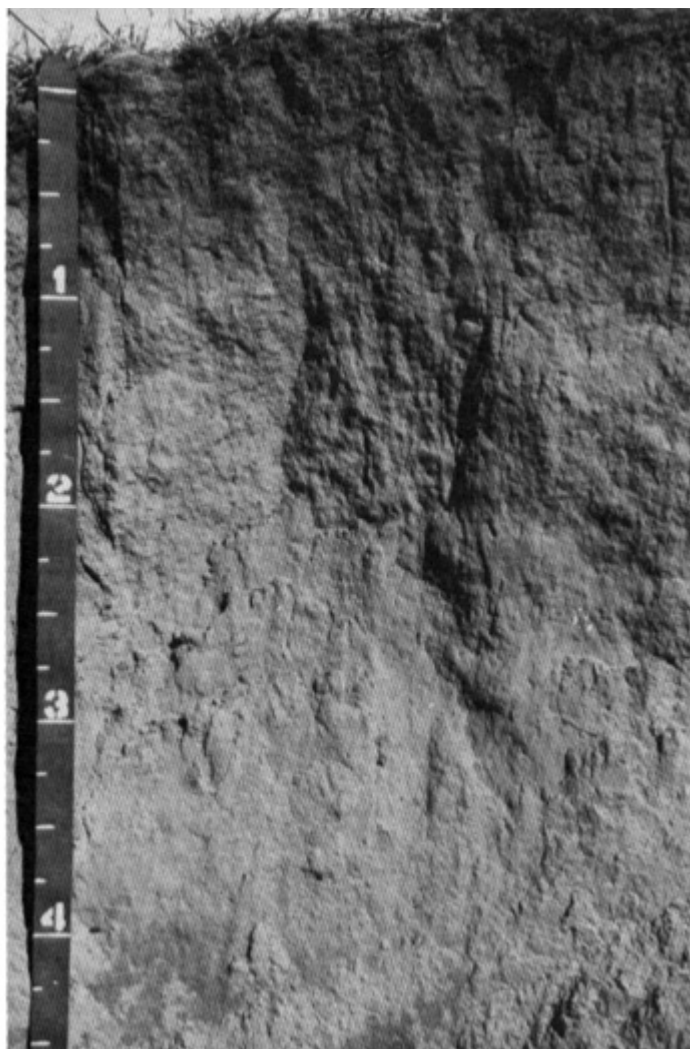


Figure 25.—Profile of Thurman loamy sand. This soil formed in mixed sandy glaciofluvial deposits and eolian material. Depth is marked in feet.

## Thurman Series

The Thurman series consists of deep, somewhat excessively drained, rapidly permeable soils on uplands. The soils formed in mixed sandy eolian and outwash deposits. The slope ranges from 2 to 11 percent.

Thurman soils are similar to Simeon soils and are commonly adjacent to Blendon, Loretto, Ortello, and Simeon soils on the landscape. Simeon soils do not have a mollic epipedon and are in similar or steeper positions on the landscape. Blendon soils have a mollic epipedon that is more than 20 inches thick; they have more clay throughout than Thurman soils. Loretto soils have more silt and clay in the upper 40 inches of the

profile than Thurman soils and are in similar positions on the landscape. Ortello soils have more silt and clay in the upper 40 inches of the profile than Thurman soils and are in similar or steeper positions on the landscape.

Typical pedon of Thurman loamy sand (fig. 25), in an area of Thurman-Ortello complex, 6 to 11 percent slopes, 2,500 feet west and 1,200 feet north of the southeast corner of sec. 7, T. 32 N., R. 1 W.

- Ap—0 to 8 inches; very dark gray (10YR 3/1) loamy sand, black (10YR 2/1) moist; weak fine and medium subangular blocky structure; slightly hard, very friable; neutral; abrupt smooth boundary.
- A—8 to 13 inches; very dark grayish brown (10YR 3/2) loamy sand, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; soft, very friable; neutral; clear smooth boundary.
- AC—13 to 22 inches; brown (10YR 5/3) sand, brown (10YR 4/3) moist; massive; soft, very friable; neutral; clear smooth boundary.

C1—22 to 47 inches; light yellowish brown (10YR 6/4) sand, brown (10YR 5/3) moist; massive; soft, very friable; neutral; abrupt smooth boundary.

C2—47 to 60 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) moist; single grained; soft, loose; slightly acid.

The solum ranges from 14 to 30 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness. Reaction is slightly acid or neutral throughout the profile.

The A horizon has value of 3 through 5 (2 or 3, moist) and chroma of 1 or 2. It is dominantly loamy sand, but the range includes fine sandy loam, sandy loam, and loamy fine sand. The AC horizon has value of 4 through 6 (3 or 4, moist) and chroma of 2 or 3. It is dominantly sand, but the range includes loamy sand. The C horizon has value of 5 through 7 (4 through 6, moist) and chroma of 2 through 4. It is commonly sand, but the range includes fine sand and loamy sand.



# Formation of the Soils

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Soil is produced by soil-forming processes acting on parent material of geologic origin. Soil formation proceeds in gradual and indistinct stages. The characteristics of a soil are determined by five soil-forming factors: the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief; and the length of time that the forces of soil formation have acted on the soil material. Four basic kinds of changes occur in soils: additions, removals, transfers, and transformations.

The factors of soil formation are closely interrelated in their effects on the soil; consequently, few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. The greatest variations in the influence of the factors of soil formation occur at or near the contact of the parent material with the atmosphere. The net effect is that generally the greatest extremes in temperature, moisture, the activities of plants and animals, erosion, deposition, and related influences bring about the greatest horizonation of soils in the upper part of the soil profile. Soil features become less distinctly contrasting with depth.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It is always required for the development of distinct horizons.

## Parent Material

Parent material is the unconsolidated mineral material in which a soil forms. In Cedar County, the soils formed in glacial till, glacial outwash, residuum of soft calcareous shale and siltstone (fig. 26), eolian sand, loess, and alluvium.

During the Pleistocene epoch, glacial ice moving from north to south carried into Nebraska a mixture of mineral material that ranged in size from clay particles to large boulders. When the climate warmed and the ice melted,

the glacial till and glacial outwash remained.

Discontinuous areas of glacial deposits are at or near the surface in the northern part of the county and are buried under loess in the southern part.

Glacial till is a heterogeneous mixture of silt, clay, sand, and rock fragments. In Cedar County it is dominantly gray and light brownish gray clay loam. Gravel, cobbles, and boulders are sparsely distributed throughout the till. Betts soils formed in glacial till.

Glacial outwash consists of sand and gravelly coarse sand. Areas of outwash are discontinuous; those at or near the surface are mainly in the northern part of the county. Simeon and Talmo soils formed in glacial outwash.

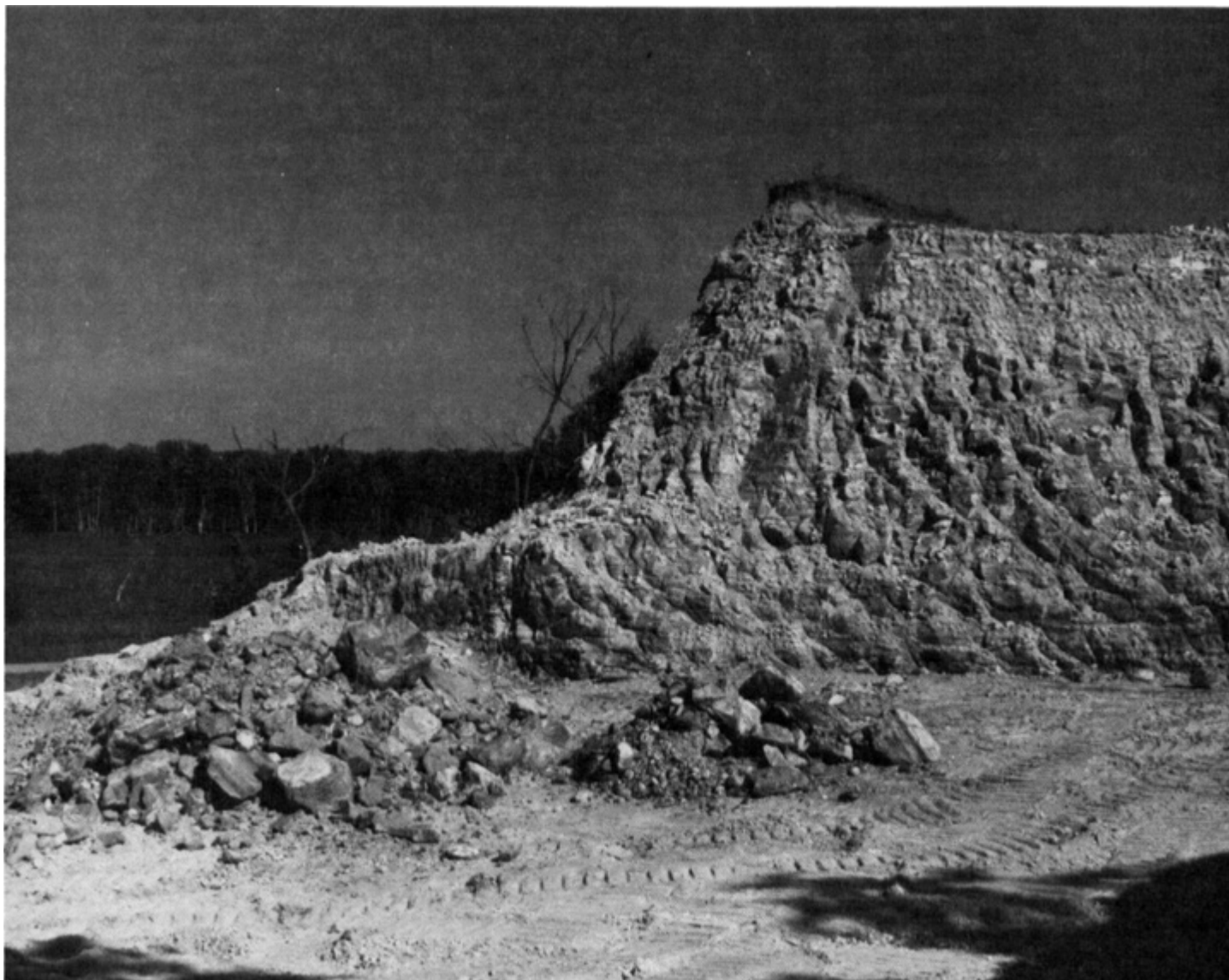
Eolian material mantles most of the county. The silty wind-deposited material is loess; it is thickest in the southern part of the county and is somewhat discontinuous in places in the northern part. Loess is the most extensive parent material in Cedar County. Eltree, Crofton, and Nora soils formed in loess. The sandy eolian deposits are mainly in the northern half of the county. Loretto and Ortello soils formed in sandy eolian material. In some areas Thurman soils formed in sandy eolian material; in other areas they formed in sandy outwash mixed with sandy eolian material.

Where rock crops out, the soils are shallow to deep over bedrock, depending on the thickness of the mantle and the weathering of the bedrock. Soft calcareous siltstone and shale weather easily into parent material. However, relief, climate, vegetation, and time have acted on this parent material in such a way that the soils are not strongly developed. Redstoe and Gavins soils formed in residuum of Niobrara Formation. Boyd soils formed in residuum of Pierre Shale. In a few places, Carlile Shale, which is the oldest bedrock formation in the county, is exposed.

Alluvium is water-deposited sediment on flood plains of streams and rivers. It is deposited each time a stream overflows its banks. In some places alluvium is as recent as the last overflow, and in some places it is on sites no longer subject to overflow.

Second bottoms, or terraces, are remnants of old flood plains which are no longer flooded or are rarely flooded. Some second bottoms are mantled with loess. Hord soils formed in mixed loess and alluvium.

The alluvium on the present flood plain is stratified according to the amount and kind of sediment deposited



**Figure 26.**—The Niobrara Formation, which is of Cretaceous age, is the bedrock underlying Gavins and Redstoe soils, at a depth of 10 to 40 inches, in the northern part of the county.

by the stream. Along the upland streams and drainageways Aowa, Baltic, Colo, Hobbs, Kezan, Lamo, and Shell soils formed in silty and moderately clayey sediment and Inavale soils formed in sandy sediment. Albaton, Barney Variant, Blake, Grable, Modale, Percival, and Sarpy soils formed in alluvium on the flood plain of the Missouri River.

Colluvium is material that has been moved downward onto a foot slope by gravity and water. It is as variable as the soils and parent material that contributed to the colluvial accumulation. Alcester and Maskell soils formed in silty and loamy colluvium.

## Climate

The climate of Cedar County is a midcontinental climate characterized by wide seasonal variations. It is nearly uniform throughout the county.

Climate has worked with other soil-forming factors in developing the soils of the county. The influence of climate has been modified, however, by local conditions in or near the developing soils. For example, because water runs off the steeply sloping Crofton soils, the microclimate is warmer and drier than in nearby areas where the soils are not so steep. The microclimate on



soils that tend to be ponded, such as the poorly drained and very poorly drained Albaton soils, is colder and wetter than that on the adjacent, somewhat poorly drained Blake soils. The microclimate on north- and east-facing slopes tends to be cooler and more moist than that on south-facing slopes. The soils on north- and east-facing slopes are more likely to be deeply leached of lime and to support natural stands of trees.

Soil micro-organisms are most active in a specific temperature range; consequently, the temperature determines the rate at which organic matter decomposes to form humus. Changes in temperature activate the weathering of parent material by water and air. Weathering also initiates changes caused by physical and chemical actions. Rainfall influences the formation of soil indirectly, through its effect on the kind and the amount of vegetation on the soil, and directly, by leaching carbonates from the soil.

## Plants and Animals

Plants, animals, micro-organisms, earthworms, and other living organisms are active factors in the soil-forming process. The kinds of plants and animals that live in and on the soil are affected by the climate, the parent material, relief, and the age of the soil.

When Cedar County was settled, tall grasses were the dominant vegetation. Trees covered only small areas bordering the bluffs, along major streams, and in some places along the Missouri River. Consequently, trees have had only a slight influence on soil development. At present, stands of trees are most common on the steeply sloping soils on the bluffs along the Missouri River Valley. Some of these stands have been in place long enough to cause slight but noticeable changes in the soils. Trees growing on alluvial soils have not been in place long enough to have a significant influence on soil development.

Grasses have been important in the development of the soils. As the grasses produced new growth above ground each year, their fibrous root systems grew in the upper few feet of the soil. In time, an upper layer formed in the soil that was moderately high in content of organic matter and was dark in color. Grass roots help to develop good soil structure and tilth. They also bring plant nutrients to the surface. This process of redistribution keeps the soils productive and the plants growing. Organic material decomposes to form various organic acids, which, in solution, hasten the leaching processes and help soil development.

Worms and small burrowing animals have an important role in soil formation. By helping to mix the soil material with organic matter, they speed up soil development and help to make the soil more friable and to aerate the soil. Micro-organisms also play an important part in soil formation. They subsist on the residue of plant material.

They break down the residue to humus, and when they die they become an available form of nitrogen for plants.

Man changes the soil mainly by causing accelerated erosion. Less obviously, he causes chemical changes in the soil by adding lime and fertilizer. Also, he causes changes in microbial activity and organic matter content by returning crop residue to the soil.

## Relief

Relief is an important factor in the formation of soils because of its effect on drainage, aeration, and erosion. The uplands of Cedar County are mainly gently sloping to very steep. The bottom lands are nearly level or are depressional. Sandy areas on bottom lands are nearly level.

Even though soils have formed in the same parent material, relief has influenced the color, thickness, and horizon distinction in the soils. The degree, shape, direction, and length of slope influence the amount of moisture in the soil. As the topography becomes steeper, runoff increases and less moisture penetrates the soil. Water moving through the soil leaches some elements into the lower horizons. On Crofton soils, which formed on steeper landscapes, runoff is medium or rapid; lime is near the surface, and there is little soil development. On Moody soils, which formed in areas that are not so steep, lime is at a greater depth and soil development is more evident.

Soils on north- and east-facing slopes have a thicker surface layer and a more developed profile. Soils on south- and west-facing slopes receive more sunlight and are warmer. The warmth increases the activity of micro-organisms and the decomposition rate of organic matter. Erosion is severest on south- and west-facing slopes. On some soils, water erosion removes soil material before horizons can form.

Relief affects the color of the subsoil through its effect on drainage and soil aeration. The subsoil of a soil that has good drainage generally is brownish because iron compounds have been oxidized and are well distributed throughout the horizon. The subsoil of a soil that has restricted drainage is poorly aerated and is generally grayish and mottled. Albaton and Lamo soils are examples. Nearly level soils on bottom lands may be wet because of slow runoff or a high water table. In areas of poorly drained soils, the decomposition of organic matter is slow or incomplete and soil development is slower.

## Time

Time enables the factors of relief, climate, and plant and animal life to bring about the formation of soils from parent material. Where parent material has been in place or has been exposed for only a short time, the factors of soil formation have not had time to act on the soil material. In Moody and Hord soils, the subsoil is well



developed and is leached of lime, an indication of moderate soil development.

Young, immature soils do not have definite subsoil horizons, and in many instances soluble calcium carbonate has not been leached from the upper layers. Albaton and Blake soils, which formed in recent alluvium, are examples of young soils. Aowa soils on bottom lands that still receive deposits and the moderately steep to

very steep Crofton soils, where erosion is removing the soil as fast as it develops, also are examples.

The degree of profile development depends on the intensity of the different soil-forming factors, the length of time that they have been active, and the nature of the material from which the soils are derived. Differences in the length of time that geologic material has been in place are commonly reflected in the degree of horizon distinction in the soil profile.

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# Glossary

**ABC soil.** A soil having an A, a B, and a C horizon.

**AC soil.** A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

**Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**Alkali (sodic) soil.** A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

**Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.

**Association, soil.** A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

**Available water capacity (available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	<i>Inches</i>
Very low.....	0 to 3
Low.....	3 to 6
Moderate.....	6 to 9
High.....	9 to 12
Very high.....	more than 12

**Base saturation.** The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

**Bedding planes.** Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Bottom land.** The normal flood plain of a stream, subject to flooding.

**Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

**Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

**Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

**Chiseling.** Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

**Climax vegetation.** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

**Coarse fragments.** If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

**Coarse textured soil.** Sand or loamy sand.

**Colluvium.** Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

**Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

**Complex, soil.** A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected

scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

**Conservation tillage.** A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—  
*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

**Control section.** The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

**Corrosive.** High risk of corrosion to uncoated steel or deterioration of concrete.

**Cover crop.** A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

**Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.

**Decreasers.** The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

**Deferred grazing.** Postponing grazing or resting grazingland for a prescribed period.

**Depth to rock** (in tables). Bedrock is too near the surface for the specified use.

**Depth, soil.** The total thickness of weathered soil material over bedrock. In this soil survey, the classes of soil depth are (1) *deep*, more than 40 inches; (2) *moderately deep*, 20 to 40 inches; (3)

*shallow*, 10 to 20 inches; and (4) *very shallow*, 0 to 10 inches.

**Diversion (or diversion terrace).** A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

**Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

*Excessively drained.*—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

*Somewhat excessively drained.*—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.*—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

*Moderately well drained.*—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

*Somewhat poorly drained.*—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.*—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage

results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained.*—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

*Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

*Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

**Excess lime** (in tables). Excess carbonates in the soil that restrict the growth of some plants.

**Fast intake** (in tables). The rapid movement of water into the soil.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

**Fine textured soil.** Sandy clay, silty clay, and clay.

**First bottom.** The normal flood plain of a stream, subject to frequent or occasional flooding.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Foot slope.** The inclined surface at the base of a hill.

**Forb.** Any herbaceous plant not a grass or a sedge.

**Frost action** (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

**Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

**Glacial outwash** (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

**Glacial till** (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

**Glaciofluvial deposits** (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

**Gleyed soil.** Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

**Grassed waterway.** A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

**Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

**Green manure crop** (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

**Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table.

**Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons of mineral soil are as follows:

*O horizon.*—An organic layer of fresh and decaying plant residue.

*A horizon.*—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.



**E horizon.**—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

**B horizon.**—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic, granular, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

**C horizon.**—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

**Cr horizon.**—Soft, consolidated bedrock beneath the soil.

**R layer.**—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

**Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.

**Hydrologic soil groups.** Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

**Increasers.** Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Infiltration capacity.** The maximum rate at which water can infiltrate into a soil under a given set of conditions.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**Intake rate.** The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2.....	very low
0.2 to 0.4.....	low
0.4 to 0.75.....	moderately low
0.75 to 1.25.....	moderate
1.25 to 1.75.....	moderately high
1.75 to 2.5.....	high
More than 2.5.....	very high

**Invaders.** On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are—

**Border.**—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

**Basin.**—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

**Controlled flooding.**—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

**Corrugation.**—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

**Drip (or trickle).**—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

**Furrow.**—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

**Sprinkler.**—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

**Leaching.** The removal of soluble material from soil or other material by percolating water.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Loess.** Fine grained material, dominantly of silt-sized particles, deposited by wind.

**Low strength.** The soil is not strong enough to support loads.

- Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.
- Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.
- Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.
- Miscellaneous area.** An area that has little or no natural soil and supports little or no vegetation.
- Moderately coarse textured soil.** Coarse sandy loam, sandy loam, and fine sandy loam.
- Moderately fine textured soil.** Clay loam, sandy clay loam, and silty clay loam.
- Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.
- Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).
- Munsell notation.** A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.
- Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)
- Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.
- Organic matter.** Plant and animal residue in the soil in various stages of decomposition.
- Organic matter classes.** In this soil survey, the ratings for organic matter content of the Ap horizon or of the upper 10 inches are:
- |                     |                       |
|---------------------|-----------------------|
| very low.....       | less than 0.5 percent |
| low.....            | 0.5 to 1.0 percent    |
| moderately low..... | 1.0 to 2.0 percent    |
| moderate.....       | 2.0 to 4.0 percent    |
| high.....           | 4.0 to 8.0 percent    |
- Outwash, glacial.** Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.
- Outwash plain.** A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.
- Parent material.** The unconsolidated organic and mineral material in which soil forms.
- Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.
- Pedon.** The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.
- Percolation.** The downward movement of water through the soil.
- Percs slowly** (in tables). The slow movement of water through the soil adversely affecting the specified use.
- Permeability.** The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:
- |                       |                        |
|-----------------------|------------------------|
| Very slow.....        | less than 0.06 inch    |
| Slow.....             | 0.06 to 0.2 inch       |
| Moderately slow.....  | 0.2 to 0.6 inch        |
| Moderate.....         | 0.6 inch to 2.0 inches |
| Moderately rapid..... | 2.0 to 6.0 inches      |
| Rapid.....            | 6.0 to 20 inches       |
| Very rapid.....       | more than 20 inches    |
- Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.
- pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)
- Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.
- Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.
- Plastic limit.** The moisture content at which a soil changes from semisolid to plastic.
- Ponding.** Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.
- Poorly graded.** Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.
- Poor filter** (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.
- Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Rangeland.** Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

**Range condition.** The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

**Range site.** An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

**Reaction, soil.** A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid.....	below 4.5
Very strongly acid.....	4.5 to 5.0
Strongly acid.....	5.1 to 5.5
Medium acid.....	5.6 to 6.0
Slightly acid.....	6.1 to 6.5
Neutral.....	6.6 to 7.3
Mildly alkaline.....	7.4 to 7.8
Moderately alkaline.....	7.9 to 8.4
Strongly alkaline.....	8.5 to 9.0
Very strongly alkaline.....	9.1 and higher

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Residuum (residual soil material).** Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

**Rill.** A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

**Rippable.** Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is

called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

**Saline soil.** A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

**Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

**Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

**Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Sheet erosion.** The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Siltstone.** Sedimentary rock made up of dominantly silt-sized particles.

**Slick spot.** A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

**Slope.** The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

**Slope classes.** In this survey, the classes of slope are as follows:

Nearly level.....	0 to 2 percent
Nearly level and very gently sloping.....	0 to 3 percent
Gently sloping.....	2 to 6 percent
Gently sloping to rolling.....	3 to 11 percent
Strongly sloping or rolling.....	6 to 11 percent
Moderately steep.....	11 to 15 percent
Steep.....	15 to 30 percent
Very steep.....	30 to 60 percent

**Slope** (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

**Slow intake** (in tables). The slow movement of water into the soil.

**Soil.** A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Soil separates.** Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millime- ters
Very coarse sand.....	2.0 to 1.0
Coarse sand.....	1.0 to 0.5
Medium sand.....	0.5 to 0.25
Fine sand.....	0.25 to 0.10
Very fine sand.....	0.10 to 0.05

**Solum.** The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, AC, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

**Stones.** Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

**Stratified.** Composed of or arranged in strata, or layers, such as stratified alluvium. The term is confined to geological materials. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

**Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**Stubble mulch.** Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** The part of the soil below the solum.

**Subsurface layer.** Any surface soil horizon (A, E, AB, or EB) below the surface layer.

**Surface layer.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

**Surface soil.** The A, E, AB, and EB horizons. The surface soil includes all subdivisions of these horizons.

**Taxadjuncts.** Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

**Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Till plain.** An extensive flat to undulating area underlain by glacial till.

**Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

**Toe slope.** The outermost inclined surface at the base of a hill; part of a foot slope.

**Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

**Upland** (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

**Variant, soil.** A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

**Weathering.** All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

**Well graded.** Refers to soil material consisting of coarse grained particles that are well distributed over a wide

range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.